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JOURNAL OF FORESTRY

VOL. 34 AUGUST, 1936 No. 8

EDITORIAL

THE QUESTION OF A PERMANENT C.C.C.

THE Civilian Conservation Corps began as a hasty improvisation. Time lacked to devise first a systematic plan for orderly building on well-considered foundations laid for permanence. Nor was the purpose a permanent structure. The basic legislation rightly labeled the undertaking "*emergency* conservation work". As such it has won an extraordinary popular approval. Now the question is: Shall the C.C.C. be continued, under a more permanent plan? And if so, with what plan?

The emergency objective was to counteract some of the evils flowing from unemployment caused by the business depression. When the C.C.C. was organized, the whole mechanism of business activity was in a state of severe breakdown. Normally, the young tend to displace the old. But in 1933 youth was adrift. Hundreds of thousands of boys and young men were wanderers. With the doors of occupation virtually everywhere closed, there was grave danger that before the doors opened much of the country's youth and promise would turn into material for the human scrap-heap.

The C.C.C. undertook to enroll these workless boys, support them for a few months, set them at useful tasks, build them up physically and in morale, and at the end turn them back upon a labor market better prepared to absorb them, as the depression passed. At the same time, through their contribution towards the support of the needy families from which they came, they were to be a means of extending relief there from the consequences of unemployment.

Unfortunately, however, the labor market has not improved to the extent hoped for. The unemployment problem of the United States is more than an emergency problem. A public program to meet it will be necessary indefinitely. The question of perpetuating the C.C.C. turns partly on how it will dovetail into such a program.

Partly—not wholly. For the purpose of the C.C.C. was not solely to relieve unemployment amongst the youth of the country, and to avert the impending economic and social consequences. The purpose also was conservation. How a permanent C.C.C. is to work in a comprehensive conservation program must also be given thought.

As a citizen, landowner, and state legislator, Franklin Roosevelt had for many years prior to the creation of the C.C.C. been deeply interested in forest conservation. As governor he had gained added familiarity with practical conditions. Under him New York had been carrying forward a long-term, far-sighted policy

of reforestation designed to restore to productivity a million acres of submarginal farm lands. In accepting the nomination of his party for the Presidency at Chicago on July 2, 1932, he said: "There are tens of millions of acres east of the Mississippi River alone in abandoned farms, in cut-over land, now growing up in worthless brush. . . . we face the future of soil erosion and timber famine. It is clear that economic foresight and immediate employment march hand in hand in the call for the reforestation of the vast areas. In so doing, employment can be given to a million men."

The Republican Secretary of Agriculture greeted the suggestion with ridicule; its meaning was distorted; and the Republican press of the country joined in a chorus of scornful hilarity. Had any stimulus been needed to induce Roosevelt to mature his plan, this might well have supplied it. Upon taking office as President, he was ready to move at once for its speedy effectuation. But it was no longer merely a plan for advancing forest conservation along with relieving unemployment. A third bird was to be killed with the same stone.

The boys and young men cut off from opportunity were to be enlisted in a great public service. This was not a wholly novel idea. In 1910 William James published his notable essay, "The Moral Equivalent of War". It urged as a desirable social measure the conscripting of all youth to serve their country in tasks of useful labor involving physical toil and hardship. A similar proposal was advanced by George H. Maxwell (the "father of the Reclamation Act") in his book "Our National Defense—the Patriotism of Peace", published in 1915.

Unlike James, Maxwell did not suggest conscription, though like James, he stressed the appeal to patriotism. The public welfare was at stake; the very life of the Nation threatened by Nature's invading forces. There was work enough for more than a million men (not boys, but seasoned adults) for generations, in such public services as planting forests, fighting forest fires, preventing floods, irrigating deserts, draining swamps, building highways, waterways, and railways. The work must be "so organized that it will furnish a substitute for the supreme inspiration to patriotism and the tremendous stimulus to energy and organized effort that war has furnished to the human race through all the past centuries."

Obviously, however, unless conscription is introduced, as Germany has introduced it in organizing her Labor Service, in the long run not patriotic fervor for a self-sacrificing service of the public welfare but the question of recompense, opportunity, and satisfactions will be the deciding question for each boy or man. The bonus is proof that in the United States even war builds up in the great body of our citizens little enthusiasm for the privilege of serving their country without regard to compensation. Also, the question of competition with other labor and of effect on the going rate of wages enters in. A permanent C.C.C. doing work which is thus taken away from others or which fails to pay what the work is fairly worth dovetails badly into a comprehensive plan for overcoming unemployment. On the other hand, if it fails to obtain a return to the public in useful work accomplished that balances its cost, as a conservation tool it would have to be rated inefficient.

Hitherto, the question of cost has not seemed very important. The planning has taken relatively little account of how to get the field projects executed economically. The whole set-up has had in view primarily the benefits resulting for the enrollees. Any plan for a permanent C.C.C. should lay much greater stress on working efficiency. This demnads, for one thing, protection from political con-

trols. It demands other changes. But revisions of the general plan are also called for with respect to its social objectives.

It is one thing to give a boy or young man a job to tide him over an emergency while private business is temporarily at low ebb; it is another thing to lift him for six months or a year out of the competitive battle only to drop him back into the thick of it no further up on the ladder of permanent employment and advancement. Temporarily, almost any job is better than none; but a job that leads nowhere and is soon over is a palliative, not a step towards solving the problem of unemployment. A permanent C.C.C. which seeks to abate the evils springing from a surplus of would-be workers must solicitously study how to develop the C.C.C. boys in ways that will enable them to get on when they leave the C.C.C. In short, far more than when the purpose was to relieve an emergency situation, success in the undertaking must depend on the skill and wisdom with which it is handled educationally.

The C.C.C. should not seek to enlist boys in an attack on the forces of Nature which require subduing to the purposes of our national life, as an adventure in public service, to their injury. As an objective, conservation performance should take second place where the enduring welfare of the enrollees is involved. The educational aim should be to prepare them for the form of work to which their native endowments best adapt them. Interruption of the normal continuity of advance from the dependence of childhood to economic independence through self-support in a gainful occupation is an economic waste. And barracks life in place of home and community life is, for most boys, an undesirable exchange.

This is particularly true when army service is involved. Militarization suppresses the spirit of individual initiative and independence, of necessity. A permanent C.C.C. should be solicitous to develop and train the boys for usefulness in civil life and peacetime occupations. To the extent that it can be so fashioned as to take boys who have not a fair chance for a start in life, either because of an underprivileged environment or because the fields of employment immediately open to them are already overcrowded, and efficiently and economically equip them for better success, it will be laid on sound social foundations. On the other hand, the recent straw vote heavily in favor of military training as a part of the C.C.C. regimen suggests a highly ominous posibility. To make the C.C.C. an adjunct of the Army would fatally change its objectives.

These objectives must be recognized as not easy to coordinate harmoniously. They pull away from each other. The conservation objective calls for getting work done that will be of maximum public benefit at a minimum cost; an investment is involved; the greater the outlay for a given result, the less becomes its economic justification. The diminishing of unemployment calls for use of the C.C.C. labor where it will not decrease the opportunity for others to work. The promotion of the welfare of youth through preparing a large number of them for greater success in life calls for training them along diversified vocational lines adjusted to their individual aptitudes, past histories, and future occupation. There is too vague a public understanding of the complexities of the problem involved. The time for improvising is past. Careful, able, far-visioned and wide-visioned planning is imperative, together with certainty that the list of objectives will not have to include the service of political interests or military ends. Either may ruin the enterprise.

PROFITS IN THE FOREST INDUSTRIES

By ALEXIS N. GARIN

Yale School of Forestry

The purpose of this article is to call the attention of foresters to the need for further enlightenment concerning a very important branch of forest economics, which so far has received but little consideration from the forestry profession. The author has not attempted to do more than very briefly touch upon some of the general aspects of the problem, because of, the limitations of space. The statements here made are based upon conclusions reached in preparing a dissertation, entitled "Corporate Profits in the Forest Products Industries", which has been submitted to the faculty of the Graduate School, Yale University, in partial fulfillment of the requirements for the Ph.D. degree.

FOREST economics has been enriched by many inductive materials during the past two decades. Yet the question of profits, the motive force of business activity, remains practically untouched.[1] With no definite knowledge of the forest industrial practices and of the financial status of the operators, little premise for a sound national policy for private timberlands exists under our system of industrial individualism.

In the United States, entrepreneurs engaged in the forest industries not only are free to choose what products they make and the volume they manufacture during a given period, but also, except to a limited extent in regard to fire protection, are free to manage their timber and forest-land resources as they see fit. How much to produce in the immediate future, whether to look forward to continued productivity and the use of timberlands or to disregard the growing of future timber crops, and many other decisions of the industrialists are made on the basis of expected profit; that is, profits are the major criterion which guide the business of capitalistic entrepreneurs—expectation of selling goods at prices above the cost incurred in their production.

The obviousness of the situation makes it unnecessary to emphasize the paucity of financial data upon which the entrepreneurs in an industry, such as wood manufactures, may intelligently base their business decisions. The numerous and scattered locations of the business units, the great variety of products produced, and the intricate pattern of modern competitive relationships make it increasingly difficult for the ordinary individual entrepreneur, by himself, to obtain the knowledge that will enable him to make sound business decisions. If the classical-economic assumption were true that the normal entrepreneur is the best judge of his own interests, the present day forest operator would require a formidable list of facts which he does not now possess in definite form. The serious matter is that no forester or economist can say how much or how little forest operators know about differences in industrial opportunities and profit rates. On that important issue no one can speak definitely until he resorts to empirical investigation.

It was this situation that suggested the study of this subject, the basic materials for which were derived from income tax returns as reported to the U. S. Treasury Department in connection with the fed-

[1]The published data on forest industrial profits and other financial conditions refer only to corporations. Based on value of products, approximately 80 per cent of the industrial activity engaged in the mechanical manufacture of wood and about 95 per cent of that of the pulp and paper industry are corporate in form.

eral income tax administration. The Treasury Department does not publish much of the information in its files, but some special studies of the data have been made by others which throw additional light upon corporate earnings.[2] The data used as the basis for my dissertation were taken from the following sources: (1) annual bulletins, entitled "Statistics of Income", issued by the Commissioner of Internal Revenue (published since 1916), and (2) "A Source-Book for the Study of Industrial Profits," issued in rototype form by the U. S. Department of Commerce, 1932. In addition to these data, certain supplementary information pertaining to special points under discussion was introduced.

The material in the "Statistics of Income" covers the entire field of corporate activity in "lumber and other wood products" and in "pulp, paper, and products" industries. The first group of corporations is further subdivided into "sawmill and planing-mill products" and "other wood products" (a more detailed subdivision is made in some reports), while the pulp and paper products group is not further subdivided. These data constitute the most extensive statistical material available, but they have definite limitations because they deal with broad financial returns compiled *en masse*, which are not broken down into specific branches of industry.

The "Source-Book", on the other hand, deals with a very limited number of corporations (190 large identical lumber and other wood products, and 111 large identical paper, pulp, and products corporations)[3] representing less than 3 per cent of the total number of lumber and other wood products corporations covered in the "Statistics of Income". However, the economic significance of the sample corporations of the "Source-Book" is much greater than mere numbers indicate. During the 5-year period 1924-1928, inclusive, the 190 corporations in the lumber group accounted on the average for about one-fifth of the total investments and sales, and over one-half of the profits, of all domestic lumber and other wood products corporations as covered in the "Statistics of Income". In the paper, pulp, and products group the 111 sample corporations represented 36 per cent of the total investments, 34 per cent of sales, and 37 per cent of the profits of all domestic corporations within that group.

The lumber and other wood products group of corporations covered in the "Source-Book" is subdivided into five specific lines of industrial activities, as follows: lumber manufacture (sawmills), planing-mill products, furniture, millwork, and miscellaneous wood products. The paper, pulp, and products group of corporations is subdivided into: blank paper, cardboard boxes, stationery, and miscellaneous paper and pulp products.

My investigation indicates that entrepreneurs in the wood manufacturing group of corporations as a whole, and in its sub-branches, have not been able to regulate production and productive capacity effectively. For instance, during the six generally prosperous years 1924-1929, inclusive, profits in the wood

[2]The published data refer to corporations, excluding individual forest industrial enterprises.

[3]Average capital per corporation in the "lumber" group (1928) was: arithmetic mean, 3 million, and median 1.2 million dollars. In the "paper" group the corresponding averages were 6 and 1.6 million dollars, respectively. The capital is measured by the following balance sheet items: (1) preferred and common stock, (2) long-term indebtedness (3) surplus and undivided profits, less deficit.

In addition to these there are data relating to from 112 to 207 small nonidentical lumber and other wood products and from 36 to 37 small nonidentical paper, pulp, and products corporations.

manufacturing group of corporations were not only low but were declining rapidly. Yet the volume of production showed no tendency to decline, and the capital investment increased; i.e., the trends were exactly the opposite to those one would expect, had the entrepreneurs acted in their own best interests.

The picture presented by the data contained in that study is not one which, in general, is conducive to the thought that the sustained yield conception of forest management can be applied generally to our privately owned forest lands unless and until the financial conditions confronting the operators become more favorable. Aggregating the annual profits for the 10-year period 1924-1933, inclusive, it was found that the wood manufacturing group showed no profit, but rather that the deficit of corporations which earned no net profit was equal approximately to the profits of those which earned a net income.[4] However, if the depression years 1930-1933 are excluded from the above 10-year period, the wood manufacturing group earned a 3 per cent return upon its invested capital.[5] During this 6-year period the average return for all manufacturing corporations was 7.5 per cent and for all paper and pulp corporations 6.5 per cent.

However, in wood manufacture as in all other industries, there are marked variations between the general average rates of profit and the rates received by the individual corporations whose income and capitals contribute to that average. The "Statistics of Income" data separate all corporations into two broad classes; namely, corporations reporting net income, and those reporting no net income. The "Source-Book", which deals with sample corporations, presents a much more detailed classification, by specific lines of business, than does "Statistics of Income". The above data indicate that the more detailed the classification, the greater are the differences in profit rates earned by the various groups of corporations. Space does not permit a detailed analysis here, but it should be kept in mind that entrepreneurs do not invest capital in the "lumber group" as a whole. Their business decisions are made and commitments are undertaken in specific industrial undertakings and products. General averages at best give only an idea of the "general drifts" which, averaged together, may not, in some respects, be the drift of the specific branches of industry; i.e., they may not represent the potential power of specific lines to contribute to the overthrow of the economic equilibrium. Hence the need is apparent for other than mere average figures.

It is an anomaly that public funds have been granted for research in practically every field except that related to the actual financial conditions of the private operators; yet foresters talk about "planned forestry", "controlled liquidation", and the adjustment of "supply to demand" as if these phrases have some significant meaning by themselves and need not be related to business reality.

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[4]The 10-year average rate of return on capital invested in all manufacturing corporations (manufacture division) as well as in all paper and pulp corporations (paper group) was approximately 4.5 per cent.

[5]Invested capital as measured by the total of the following balance sheet items: (1) preferred and common stock, (2) bonded indebtedness and mortgages, (3) surplus and undivided profits, less deficit.

By profit or net return is meant here the net earnings after payment of all business expenses and fixed charges, including federal income and excess profits taxes; i.e., the surplus legally available for proprietorship, plus interest paid on bonds and mortgages. Imputed interest on capital and rent on land owned by stockholders, which do not explicitly call for payments, are not considered as costs and, therefore, are not deducted from gross income in arriving at the profit.

To some foresters, public ownership or public supervision of cutting on private lands are the only methods for bringing about the practice of large-scale forestry. It must be recognized, however, that there is no crystallized public opinion in favor of coercion and that the question of immediate and complete public ownership cannot be considered of more than academic interest. Consequently, as far as we can see into the future, we always shall have both public and private forests. Any forest policy imposed upon private forest landworkers by public agencies without regard to their financial conditions would involve more complexities than some foresters apparently realize. The present public policy appears to drift in a seemingly logical direction, toward "contrived" private forestry through financial aid to forest owners who accept the principle of permanent forest management. The two most outstanding features which are proposed as an aid to the private owner are federal long-term forest credit and federal acquisition of "surplus" undeveloped timber which the owner is unable to carry under our system of capital value taxation.[6] These proposals raise complex questions concerning the probable economic effects of deliberate piecemeal attempts to apportion capital and the rate of profit within competitive industries.

As a general principle it is clear that, whatever the prospects for improved control and stabilization of forest industrial activities, a primary essential is information concerning the current economic status and the prospects of the principal forest industries in the country; i.e., data concerning sales, investments, profits, and other operating conditions. This applies both to the government and to the private operator. Neither agency now has adequate information of this character. Certain trade associations collect confidential data from their members and thus contribute towards better individual business planning, but the complex industrial and sectional competitive relationships make this form of information insufficient. To be sure, the trade associations could do a valuable service to the industry through their further efforts to bring about improved cost accounting methods and fuller publicity of accounts. Without these essential conditions the widely scattered and noncoordinated production units will find it increasingly difficult to cope successfully with industries of a more unitary character which produce competing products.

The annual collection, analysis, and distribution of comprehensive (but simply presented) data concerning the forest industrial operating conditions would be a matter of relative simplicity, since the U. S. Treasury Department, in connection with the federal income tax administration, now collects the necessary basic statistical material. Although a substantial appropriation of money would be required for the preparation of existing data and for the establishment of the necessary standards, only limited funds would be needed to continue the work from year to year.

It is not implied that the foregoing statistical questions are the only ones to be solved. On the contrary, there are other very serious problems which face the industry. For one thing, there is the comparative instability and decline in the demand for wood products, due to the increased diversification of man's

[6]The proposal that the federal government buy up submarginal timber holdings (and presumably retire them from operation) suggests "socializing losses" due to bad industrial judgment. As this is a costly procedure, I do not hazard to say to what extent this proposal will be followed by the government. Neither is an attempt made here to balance public gains and losses from such a procedure.

wants as a result of general industrial progress. Apparently the demand for wood products the form of which has not been changed from the natural one (lumber products) has become stabilized to the extent that a price decrease brings about only a limited increase in sales. The demand cannot be materially increased other than by the discovery or adoption of new methods of wood utilization, particularly of low-grade material, and by further development of other allied industries. However, complete current statistical data concerning operating conditions in the industries using wood as a basic material appear to be the first prerequisite for improvement of forest industrial conditions; they are essential for any intelligent centrally directed attempt to guide forest industrial policies and practices.

Stuart Forest Tree Nursery Dedicated

A forest nursery on the Kisatchie National Forest near Alexandria, La., was dedicated on June 17 to the memory of Major Robert Y. Stuart, late Chief of the Forest Service. E. A. Sherman, Assistant Chief of the Forest Service delivered the principal address at the ceremonies.

Establishment of the nursery was approved by Major Stuart shortly before his death in the fall of 1933. It began operation in 1934, and during the first year of operation produced nearly 10,000,000 tree seedlings, mainly longleaf, with smaller quantities of slash and loblolly pine. In 1935 the output was raised to approximately 42,000,000 seedlings, the majority of which were used in Louisiana and Mississippi.

THE PROPOSED MOUNT OLYMPUS NATIONAL PARK

By C. S. COWAN

Chief Fire Warden, Washington Forest Fire Association

THE Wallgren Bill, fostering the Mount Olympus National Park, is, to my mind, a sample of the lengths to which misguided and misinformed enthusiasts will go to carry their points.

I would ask you to look at the problem from its several angles. In the first place, who is behind this bill? We who are on the ground—so to speak—can go back to the point of origin. When the bill was first mooted, there was a meeting at the Seattle Chamber of Commerce in which the case for the Park was to be outlined by an executive officer of the National Park Service. It developed during the meeting, however, that the boundaries as they were set in his mind no longer existed, but had been extended as in the present bill. This was the first intimation this official had of the proposed extension. His reply, however, was that "if this is what the National Park Service recommends, I am for it one hundred per cent." In other words, an official of this standing had no mind of his own, no opinion of his own, but was willing to carry departmental policy to any length, just so long as the Department recommended it. The need for such extension was not a point for consideration. The thing that mattered was that the Department thought it would like such an extension. That was enough.

We are told of the Emergency Conservation Committee, but we are not told who the Emergency Conservation Committee is. As a matter of fact, the chairman of this Committee refused to reply as to who her Committee actually were. Is the movement altruistic? The answer is as old as politics. We were mercenary—the tools of the interests; they, the white-haired boys.

Have the members of this Committee ever been on the ground? We have no definite knowledge of this, but we have grave cause for doubts, as evidenced by statements made which show little definite knowledge of things as they are.

Mr. Wallgren himself is quite enthusiastic. He is supposedly a nature lover, but his love of nature and knowledge of western flora is such that when he presented a picture of a huge tree, as a sample of the timber it was proposed to include within the new boundaries of the proposed Mount Olympus National Park, he informed the members of the Congressional committee that it was a giant Douglas fir. It was actually a Sitka spruce. He also stated that "this picture was taken in the Clearwater Valley, in the area it is proposed to include within the new National Park." The photographer who took this picture, being present, stated it was taken on the Elwha River, and was already included within the boundaries of the present National Monument. Obviously, Mr. Wallgren's knowledge comes from misinformation and not personal acquaintance.

Let us look a little further. The present Mount Olympus National Monument contains some three billion board feet of virgin timber. If our tourists and nature lovers were really to see all this timber, it would take them a month. We know, however, that tourists in the main want to travel through the country at a fair number of miles per hour, preferably in an automobile. Very few of them have the inclination, or time, to get into the timber itself. They must

have roads. Under the proposed National Park, such roads could not be built. For whom then, is this timber required?

There is also this point, which must never be forgotten. Tourist travel does not come from nature lovers as such, but does come from *industry*. Industry must supply the wages which creates "tourists." Are not the people and industries of the Olympic Peninsula entitled to consideration? Must their natural resources be tied up for twelve months of the year, in order that a possible three months' tourist season can be created? Is the proposed Mount Olympus National Monument area suited to a National Park? Past committees have said, no! Has the present Park Administration really made a study of the situation and presented a report for public guidance which would alter this negative report? None has been made public to my knowledge.

The extension of the boundaries of the west side takes in the area of the greatest rainfall in the continental United States. The area on the east side, which is more readily accessible, has not been included. Apparently, only those areas are beautiful which carry commercial timber.

The so-called conservationists want to preserve a raw industrial resource at the expense of the people who live in that area. The fact that tourists are the offshoot of industry seems to be forgotten. The preservation of scenery is generally held to be, firstly, of aesthetic value to our people, and secondly, a means of attracting tourist travel. But tourists without cash resources are unwelcome. Several states have, of late, taken extreme measures to keep these cashless tourists out. In this case they call them hobos. But such people may easily be as appreciative of scenery and timber as are those who are fortunate enough to be employed in industry long enough to accumulate a reserve for travel at their own expense.

A mass of figures has been presented and distorted. At a local Society meeting recently, a representative of the Park Service analyzed the timber resources of this area and proved, at least to his own satisfaction, that the available amount of merchantable timber was simply 27 million feet. This, of course, is laughable, but it does show the lengths to which the Park Service officials are willing to go in order to gain their point. To make the matter funnier, he quoted these figures as coming from Mr. Silcox.

At one time there was a saying that "a patriot is a man who regrets that you have but one life to give for his country." It is rapidly becoming a truism that the conservationist is a man who regrets that you have but one piece of property he can take for his individual pleasure.

Now of the local enthusiasts, whom are we concerned with? This is not meant as an attack upon any individual, or upon the reasons advocated by that individual, but must be considered as we diagnose the reasons behind the fervor with which our conservationists are pushing this scheme forward. One man has the record of having cut the only piece of virgin timber which has been logged along the shores of Lake Crescent, through which the highway runs. Yet this man carries the torch locally. What has caused his change of mind and change of attitude? Has the fact that he is seasonally employed by the National Park Service something to do with it? But until recent years his actions were diametrically opposed to his statements of today.

What is the other side of the picture? The state exchange area, in conjunction with National Forest timber land, forms an area of sufficient size to set up economic sustained yield areas. The timber on Indian lands was not taken into consideration—the Department of the Inte-

rior had other plans. These plans called for stumpage sales. As far back as 1928, the matter was discussed as between the state Land Commissioner and the U. S. Forest Service. In 1931 the Olympic Sustained Yield Bill passed the legislature and became law. This meant that the state lands, the income from which goes to the support of the schools and higher educational institutions, together with timber which is behind the bonds of the state Capitol Building, were now in a position to be managed for their fullest economic return. The fullest economic return, in this case, means managed forests, means sustained employment, means full use of the land for twelve months of the year, means that established communities will have assurance of continuity. It means economic stabilization for those communities, it comes nearer to the promise of local social security than ever before.

This plan is termed by the Department of the Interior the plan of "the interests" —the cheapest and most common retort of those who have their own schemes. The Department of the Interior would thus brand, for public consumption, the first step to put into practice those sustained yield principles that foresters have been advocating for half a century. The President insisted that provision be made for reforestation under the Lumber Code. Under the Department of the Interior code, such a plan is a scheme of the Lumber Barons!

Into all this welter of words put forward by interested parties; by parties who are riding hobby-horses; parties who have personal spites to gratify; parties who are taking every possible means to place themselves before the public, the conservationist is being pulled, misinformed, and misled. A resolution of the Board of The American Forestry Association favors "the permanent preservation of a substantial body of the finest primitive forest within the region of the present Mount Olympus National Monument". This Board believes that three billion board feet of virgin timber is a substantial body. This amount is already within the boundaries of the present Mount Olympus National Monument. Why the need for further resolutions? Apparently it is necessary to tell the Department of the Interior that 3 billion feet is 3 billion feet.

Does the Board believe that their recommendation to appoint a committee of disinterested experts outside of governmental service is going to be conceded by the Department of the Interior, or the Department of Agriculture? Moreover, does it believe that it is possible to get a committee of disinterested experts, or even that we have experts available? The question really is, shall we preserve the raw materials of industry so that a people shall live, or shall we preserve scenery, and forbid the means of securing the wherewithal by which scenery becomes available to the public?

Would it not be better to appoint a committee of those who are frankly interested in both sides of the proposed bill? We can then have a businesslike settlement, which would safeguard the interests necessary to the well-being of the people of the state of Washington, would preserve to the Nation a body of timber which, any fair-minded man would say, would be an asset to the country, and would also take into consideration the fact that the value of the state land grant, which is a bank reserve for our school system, should not be depreciated by taking out of production an area of timber necessary for the preservation of our local industries in a well-laid and well-founded proposal for a sustained yield program.

THE OTHER SIDE OF OLYMPUS

By W. H. HORNING

Branch of Forestry, National Park Service

The author of this paper is on leave of absence from his position of Assistant Professor of Forestry at Iowa State College, in order to pursue certain investigations as a temporary member of the National Park Service. One of his assignments has been to make a special study of the Mount Olympus area, with which he was previously familiar. In the following article he presents his personal reaction to what was said in the article entitled "The Proposed Mount Olympus National Park" which the June JOURNAL carried under "Briefer Articles and Notes".

THE June issue of the JOURNAL contained a comment on the bill before Congress to establish a National Park on the Olympic Peninsula, in the State of Washington. It was indicated that the Society of American Foresters may be called upon to express an official opinion on this bill, and that it would therefore be desirable to have a discussion for the purpose of informing the membership as to the merits of the case.

The writer is inclined to question whether it is a proper function of the Society, as such, to express an official opinion on this question. The objectives of the Society as stated in Article II of the Constitution are as follows: "The objects of this Society shall be to represent, advance, and protect the interests and standards of the profession of forestry, to provide a medium for exchange of professional thought, and to promote the science, practice, and standards of forestry in America."

Apparently no vital interest of the forestry profession is at stake, nor is there any important question of forestry standards involved. The principal issue is a decision as to which of two types of land use shall be applied on a particular area of public land. This has become a question for Congress to decide, and it is not properly the concern of the Society of American Foresters. When the wishes of the public owner have been expressed through the medium of Congressional action, it will then become the duty of foresters, technicians, and public land administrators to shape their plans accordingly.

The bill before Congress would extend an existing National Monument, administered by the National Park Service, by adding to it certain areas of great scenic and scientific value now administered by the U. S. Forest Service. The Park Service favors this proposal, while the Forest Service vigorously oppose it. Each of these organizations employs a considerable number of well-qualified foresters, many of whom are members in good standing in the Society. It is the function of the Society to promote the interests of both groups, but not the interests of either one at the expense of the other. This should hold true even though the sympathies of individual members, or a majority of them, may favor one side more than the other.

No matter which way Congress sees fit to decide the matter, the forests involved will continue to receive the care and supervision of foresters who are members of the Society. In view of these circumstances it seems very doubtful whether the Society should make an official recommendation either for or against the proposed Park. To do so may harm rather than promote the best interests of the profession.

However, as this case has already received considerable public comment, in the pages of the JOURNAL and elsewhere, much of which has been adverse to the

proposed Park, it may be timely to present some of the arguments on the other side. The following comments and statements are offered in the hope of contributing something toward a better understanding of the case by the members of the Society.

The preceding article in the present issue of the JOURNAL calls attention to the fact that tourist travel comes from industry. This is true in the sense that income necessary to support tourist travel has been earned by someone, at some time or other, in some sort of productive enterprise. But a very large portion of the tourist travel to a National Park will be based on income earned in industries far removed from the Olympic Peninsula. A great deal of this income will be earned in industries based on other things than timber. It is hardly to be denied that tourists whose income is derived from other industries, in other parts of the country, have an interest in what happens to a National Forest or National Park, regardless of the particular state in which it happens to be located.

Forestry or forest management has been defined as "using the specialized knowledge of forestry to make a forest property best serve the purposes of the owner."[1] In the case of the Olympic National Forest the owner is the American public, not merely the industries of the Olympic Peninsula. This complicates the problem because it is difficult to determine the real wishes of the owner. The Forest Service has adopted the plan of determining what the wishes of the owners ought to be if based on the best available information as to values and the economic and social factors involved. This has been carried out for the National Forests under the ideal slogan, "The greatest good to the greatest number in the long run", and the policy has met with public approval. In practice, this has given rise to the idea which has been popularized in the words "multiple use". In some cases multiple use means several uses concurrently on the same ground. For example, timber production, grazing, and recreation may be managed on the same area at the same time. This usually necessitates some sort of compromise between the several conflicting interests, with none of the three being developed to the full extent, but "the greatest good to the greatest number in the long run" is probably approached. In other cases, multiple use means classification of a National Forest, with certain areas being designated for grazing use, others as timber-production areas, and still others as recreational areas. Recreation tends to be a more or less exclusive use because people object, for example, to livestock defiling campgrounds or water supplies. Also, people object to the unsightliness of areas where logging has been permitted. Multiple use on the Olympic National Forest means a large degree of classification, with certain extensive areas being designated specifically for recreational use. The forester, in attempting to determine how best to satisfy the wishes of the owner, has had to study the uses which the public has demanded, or appears likely to demand, from this and other similar properties. In attempting to appraise the values of different portions of the area, many more or less conflicting and incompletely understood influences have had to be interpreted. Plans have been written, and it is to be anticipated that errors may have been made. With the lumber industry so highly developed on the Olympic Peninsula and many foresters being rather utilization-minded, it may well be that the plans have erred in the direction of classifying too much of the timber area for commercial utilization. It would probably be preferable

[1]Definition by Herbert A. Smith.

to err on the side of reserving more of the primeval forest than now appears absolutely necessary. If more is saved than future generations deem necessary, they will have an opportunity to reduce it. On the other hand, if this is decided for them by cutting too much now, the mistake cannot be rectified, because, while it is true that a forest can be regrown, it is very unlikely that it will contain the huge trees and other unusual conditions characteristic of the present primeval forest.

The denial that the area is suitable for National Park purposes disregards the fact that all interests represented at the Congressional hearings on the Park proposal, excepting the Forest Service, advocated a National Park. The witnesses and petitions heard at the hearings were about equally divided in favoring or opposing the Wallgren bill, but with the exception of the Forest Service representatives all agreed in favoring the establishment of a Park. They disagreed chiefly on the question of size and exact location of boundaries. A number of organizations interested in outdoor recreation and familiar with National Parks have sent their representatives to examine the Olympics at some time or other. Without exception the reports from such studies have been enthusiastic about the wonderful scenic quality of the area. Naturally there have been differences of opinion as to the scenic quality or recreational value of specific features.

The Forest Service itself has recognized the unusual scenic quality of the area in its public-use maps and folders. It has acknowledged recreation to be the highest use for most of the area in question by drawing up an elaborate recreational plan. This plan proposes to set aside several types of areas for almost exclusive recreational use, which are classified as follows: an extensive snow-peak recreational area; a large primitive area to be kept inviolate from all commercial development; lake settings to be reserved from timber cutting; and, in addition, an extensive area of bottomland strips along roads, trails, and streams, including the heaviest and most accessible stands of large virgin timber. All of these classes of areas taken together include almost as much area, much of it the same area, as the Wallgren bill proposes to include in a National Park. They include about half as much total volume of timber as the proposed Park.

Examination of the two opposing plans for the management of the area—the National Park plan versus the multiple use plan of the Forest Service—reveals relatively little difference between the two as to area involved. Both of them set aside a considerable area on which recreation shall be recognized as the dominant use. Both of them in doing so withdraw a considerable quantity of potentially commercial timber from logging, and do so for a similar reason. This reason is that recreational values are high and of such a character that they would be seriously diminished by destruction of the virgin forest condition. Logging of such areas would produce economic values and support pay rolls, but at the same time would destroy a forest condition which has equal or greater earning power, just as it stands, without being converted into transportable merchandise. Economic value attaches to either goods or services which have the power to satisfy human wants. In this sense many intangibles possess economic value. Human beings expend considerable energy and money to gain or enjoy them, and it is obvious that human wants are satisfied by them just as truly as they are by substantial goods. In this case, if the intangible values which the Nation will gain from preserving the area exceed the value of the tangible goods which might otherwise be produced, the public interest will be served by forgoing the production of these goods.

Areas of inspirational character, while apparently rather abundant in America, are all too rare in proportion to the need for them. The Olympic area is one of the finest and rarest of all that the Nation possesses.

Entirely aside from arguments as to board feet or profit and loss, this area is so wonderful that it should be saved for what it is. There are certain things in the world which are almost beyond price. The marvelous art of the "Creation" and "Last Judgment" by Michelangelo in the Sistine Chapel are beyond price. We cannot speak of these in terms of stone and canvas or of pay rolls. They have been a source of joy and inspiration to the entire world for many generations. While they attract tourists to Italy, their value to the human race is incalculable and grows with the passing of time. Mount Olympus is somewhat in this same class. Its glacier-clad magnificence is almost beyond description, and its setting of superb rain-forest is equally priceless. It is a masterpiece of nature which should be saved, as nearly as possible just the way it is, for the joy and inspiration not only of the present generation but of those to follow.

It would be unthinkable to change the architecture of the Vatican along modernistic lines to house machines for the production of a sustained yield of commercial goods for sale to the thousands who go there to draw inspiration from its priceless works of art. It is almost equally unthinkable to change the grandeur of the essential forest setting of Mount Olympus for the sake of producing a sustained yield of lumber or pulp.

Foresters are naturally interested in the charge that establishment of the Park will prevent the practice of sustained-yield management on the Olympic National Forest and adjacent timber lands. As a matter of fact, it will require only modification of the existing sustained-yield plans of the Forest Service, which are still in the formulative stage. The portions of the National Forest remaining, after withdrawal of the proposed Park, will contain more than 20 billion board feet of timber, and this includes most of the timber which is economically available for commercial cutting. This, of itself, would be ample to justify sustained yield management, but there is an additional volume of 40 billion board feet in other ownerships which may possibly be combined with the National Forest timber for management.

In considering timber in this area it is necessary to consider more than total volume. Considerable portions of the timber are not now economically available for commercial use, and probably never will be. This fact is recognized by the forest survey recently completed by the Forest Service. When allowance is made for this fact and the discussion is limited to timber possessing value for probable future commercial use, the effects of the proposed Park are quite different from what its opponents have advertised them to be.

Only a portion of this timber is suitable for cutting by the present over-developed sawmill industry. Most of the remaining timber is better suited for pulp production, and the sawmill industry is facing sharp curtailment even if no Park is established. It is hoped that a pulp industry will be developed to take the place of the sawmills. Development of this industry, on a sustained-yield basis and on the scale necessary to replace the waning sawmill industry as a source of industrial pay rolls, appears possible whether or not the Park is established. Take, for example, Grays Harbor, which is more seriously affected than any other community by the proposed Park. The forest survey shows that all of the tributary area includes a present stand of 50 million cords of

economically available pulpwood. This is enough, without allowing for new growth, to permit continuous full capacity operation of ten 200-ton pulp mills for 50 years. Grays Harbor has one such mill at present. New growth of pulpwood on the same area is already occurring at the rate of 400,000 cords per year. Potential growth, if good forestry were put into practice, is estimated at 1,790,000 cords per year. If only two-thirds of this becomes realizable, Grays Harbor can anticipate a sustained annual yield of more than a million cords, which is enough to support the ten 200-ton mills continuously. This would seem to offer ample latitude for sustained yield forestry outside the proposed Park.

The plans of the Forest Service have been prepared by qualified foresters, and, no doubt, are good. Also, they are flexible and subject to modifications to meet changing conditions or demands upon the part of the public owner. In theory this flexibility is a desirable feature, but unfortunately it is also a vulnerable point. The arrangement whereby the counties in which a National Forest is located receive 25 per cent of the Forest receipts provides a temptation for the local politicians to bring pressure to bear, in all sorts of ways, to induce the Forest officers to make more and larger timber sales. As time goes on, it may become more difficult to resist such pressure successfully, and, if so, forest working plans may be modified contrary to the policy of "the greatest good for the greatest number in the long run".

In the case of the Olympic plans, this might easily result in the gradual cutting of timber which impartial judgment would preserve, as provided in the present plans. The best interests of the public owner would thereby be sacrificed for the benefit of a purely local interest. If, on the other hand, the area is definitely set aside as a Park by act of Congress, the policy of management will be quite definitely fixed until Congress itself sees fit to order a change. Such a plan lacks the flexibility which seems desirable in a management plan for commercial timber areas. But for areas which are quite definitely of the rare and superlative quality appropriate for a National Park, this plan possesses an important advantage. It offers greater security for areas where preservation is more in the public interest than are exploitation and utilization of material resources.

Under such a plan, management policy is less easily changed on short notice to suit the dictates of local expediency. By virtue of this fact the Park plan has much in its favor as a choice for proper management of an area which should be preserved in the primeval condition.

THE NORTHEASTERN LUMBER INDUSTRY[1]

By E. W. TREEN

Executive Secretary, Northeastern Lumber Manufacturers' Association

In discussing the situation of the northeastern lumber manufacturing industry, its position in the national industry picture must be given just consideration. From our viewpoint, the effect of outside influences is a more important consideration than what percentage of the national cut is produced in the Northeast or what percentage of United States lumber shipments originate in the Northeast. Of the total national production of softwoods and hardwoods, our percentages are relatively small. That production, however, and the opportunity to make a reasonable profit on the investment involved, is of extreme importance to the manufacturer in Maine, the Adirondacks, or any other producing section of the Northeast.

The greatest volume of national lumber production is in the Far West and the South. It will continue to be. The principal consuming markets are in the area east of the Mississippi and north of the Ohio-Potomac Rivers. That probably will not change greatly. The principal directions of lumber movement are, therefore, north and east. The great movement is into the eastern markets, in which the northeastern manufacturer must sell his lumber.

A few figures will perhaps illustrate these points. According to Department of Agriculture figures 95 per cent of northeastern softwood production is sold in northeastern territory; 21 per cent of the West Coast cut and approximately the same percentage of the southern pine are also sold in that territory. Of imported softwoods, the December, 1935, figures of the Department of Commerce show a situation not greatly different from that of many years previously. Of 16,700,000 board feet imported, 10,200,000 feet came directly into the Northeast through northeastern customs districts, from Maine to Buffalo. Much of that entering the Duluth and Superior customs districts will eventually reach eastern markets. Of imported spruce, 75 per cent came in through northeastern customs districts.

According to Department of Agriculture figures, 92 per cent of northeastern hardwood production is sold in northeastern territory; somewhat over 15 per cent of the Appalachian and southern cut comes into northeastern territory. Of imported hardwoods, the December, 1935, figures of the Department of Commerce show a situation more intensified than for softwoods. Of 2,750,000 feet imported, 2,170,000 feet came through northeastern customs districts. Of imported birch, beech, and maple, 80 per cent came into northeastern markets.

The position of the northeastern manufacturer may be summarized as follows:

Sale of his production is limited practically 100 per cent to northeastern markets, for these reasons:

There is no market to the north, because Canada produces enough and more for its own markets of the same species which we produce.

He cannot ship west or south into inland United States because of very unfavorable freight rates as compared with

[1]Presented at the meeting of the New England Section, Boston, Mass., February 21, 1936.

those into that territory from other producing sections.

There is no market to the east because of the Atlantic.

Truly the northeastern sawmill man is between the devil and the deep blue sea!

Facing these facts, what kind of a cooperative advance to promote the welfare and protect the interests of northeastern lumber can be and has been undertaken? We know our spruce and white pine, our birch and hard maple, rate highly in workability, strength, appearance, and finishing qualities. We are optimistic enough to believe that there will be a fine supply for years to come. We are not suffering under the delusion that we can supply all the demands of the great northeastern market. The program of the Northeastern Lumber Manufacturers' Association is designed to maintain and possibly extend the present markets for northeastern hardwoods and softwoods and to reverse the opinion you have heard expressed in the statement: "There isn't any more good lumber in the Northeast."

What is the Association doing to carry out that program? I shall endeavor to cover the various phases as briefly as possible.

Stabilization of Softwood Grading Rules.—At the beginning of the Code period, committees of our white pine and spruce manufacturers formulated rules for the grading of those two species. Factors taken into consideration were trade requirements based on experience, the characteristics of the woods, and the competition of other species. The National Hardwood Lumber Association rules, of course, have provided for many years the standards of hardwood inspection.

Through the experience of years of more complete industry organization, the larger softwood producing associations have developed grading rules and inspection practices which have been of tremendous advantage in the successful marketing of their products. In addition there has been, in cooperation with the National Lumber Manufacturers Association, the development of the grade-use guides, which have enabled the retail and consuming trade, engineers, and other wood specifiers to specify the proper grades for different uses. For structural purposes there have been developed the structural grades, based on stresses and other strength factors, important from a structural engineering standpoint. The Northeastern Lumber Manufacturers' Association is now engaged in a study of these factors as applying to spruce and pine. It is expected that conferences and test inspections will be conducted during the next few months whereby the grade-use guides and structural stress grades may be published for our softwoods. Our present grades, which have been accepted as standard for northeastern woods and specified by the principal government purchasing departments, will be further clarified with the intention of publication.

The Association adopted the grading rules of the Northern Hemlock and Hardwood Manufacturers' Association for eastern hemlock. It is appreciated that certain types of New England hemlock may require special treatment, and it is hoped that situation can be given attention later.

A big step forward has therefore been made in the stabilization of northeastern grades. With cooperation of our manufacturers, much more can be accomplished.

Contact with Public Purchasing Agencies.—Even before the expiration of the Code period, the Association was diligent in its contact with those agencies which have been large purchasers of lumber for some years and will probably continue to be, to assure northeastern woods being given equal preference in northeastern territory with other species, for

uses for which they are suitable. As just stated, these government purchasing departments are specifying our rules and species. Through the deputizing of efficient inspectors, the Association has provided the means whereby Association certificates of inspection may accompany invoices of softwood lumber shipped on government contracts. Several millions of feet of northeastern spruce and pine have been used on the Quoddy Bay project, with general satisfaction.

Freight Rates.—Bearing in mind that northeastern lumber must be sold in this territory, it is not hard to appreciate that, if the competitive balance is to be maintained, the consideration of the freight-rate situation must be continuously in mind. The tremendous increase in tonnage of West Coast lumber moved through the Panama Canal to the eastern markets during the past ten years at lower than all-rail rates has had a great effect on the markets for northeastern woods. It has also affected greatly the revenue of the transcontinental and connecting railroads. By reason of this, the purpose stated being to divert water tonnage back to the railroads, the proposal was made last spring to reduce the transcontinental rate 20 per cent, or a reduction from 90 cents to 72 cents per hundred-weight. Considering this inimical to its interests, the northeastern lumber manufacturing industry, through our Association, opposed it. We were at first successful, but later the Interstate Commerce Commission ordered the publication of the 72 cent rate, which became effective last August.

The Southern Pine Association promptly made application for similar reductions into Official Classification territory which includes the northeast, and was granted such, varying from 8 to 18 per cent.

All of these reductions meant lowering of delivery charges of competing species into northeastern markets. Our Association therefore took action before the carriers, and was successful in bringing about, effective February 10, a 12½ per cent reduction of freight rates between originating points and destinations in this territory. This has not brought about a restoration of the competitive balance, but has accomplished a considerable approach to it. This, we feel, is a positive demonstration of what co-operative action in the northeastern industry can bring about. There are other traffic problems to which we hope to give attention at the proper time.

Promotion and publicity.—Such work, effectively done, requires considerable expenditure. The Association, however, has taken the first steps in the proper direction. We exhibited a quite complete display of northeastern woods at the January convention of the Northeastern Retail Lumbermen's Association. That brought our products home to the northeastern retail lumbermen and wood users through whom the majority of our production must be marketed. We have other plans under consideration.

National Affiliation.—The Northeastern Lumber Manufacturers' Association is affiliated, as a regional association, with the National Lumber Manufacturers Association. We thus have national recognition and are enabled to have a voice in national industry questions.

Conservation.—Article X of the Lumber Code provided that the industry would undertake, in cooperation with public and other agencies, to carry out practicable measures to effect conservation and sustained yield of forest resources. Article X further provided for the initiation and administration of such measures by the industry within each division, in cooperation with the appropriate state and federal authorities. Most of you are familiar with the progress made under Article X in the Northeastern Division, so it isn't necessary that it be repeated here. Suffice it to say that the North-

eastern Lumber Manufacturers' Association has established, since its reorganization, a representative committee on conservation, which is well informed on conditions in the Northeast and prepared to cooperate on practicable measures which will help insure the perpetuation of the forest industries in the Northeast.

I cannot leave this question of conservation and sustained yield, however, without touching on the subject of taxation. For some time it has become increasingly evident to enlightened men in both the lumber and timber products industries and the forestry profession that one of the principal, perhaps *the* principal, drawback to the practice of sustained yield principles is the oppressive system of timber taxation.

The lumber industry is a business in which capital has been invested, the same as any other business. If the industry is to be perpetuated, the total cost of producing the product must not exceed, over a period of time, the realizable market value on that production. The man who puts his money into timber and lumber manufacturing is entitled to a reasonable return and a fair profit on his investment. We all realize that is a sound principle. There is no reason to expect privately owned forests to be run on other principles than those generally accepted in business management.

The lumber industry has been penalized by a tax system which in some cases has invited or compelled the timber owner to strip his land. Taxes are levied year after year on the same timber, the only crop which is thus penalized by reason of its growth. It has made it necessary to remove the crop before such time as the capitalized tax investment arrives at an unrealizable return figure. In the report of the Forest Taxation Inquiry of the Forest Service is this statement: "In spite of the many-sided public interest in conservative forest practice, the public, through the property tax, is subjecting the forest business to an influence directly opposed to conservation . . . . Enough has long been known to set up a reasonable presumption that the American tax system, especially the property tax, acts as a discouragement to forest growing and may in some cases affect adversely the utilization of mature forests."

If conservation and sustained yield are to reach that degree of accomplishment desired by practical business and professional men, some means must be devised to change the present system so that the burden of taxes paid prior to realization on the property taxed, will be lightened. It should be worked out to relieve the timberland owner of the necessity of financing tax payments in advance of income received from the timber. The yield tax plan would be the solution in very large part.

The problem demands the concentration of the best minds in forestry and the timber business. It could, if properly solved, do more to bring about general application of sustained yield principles to growing timber and to lumber operations than any other plan yet devised. Until the problem is solved, the goal will not be reached.

A STUDY OF THE GYPSY MOTH IN THE TOWN OF PETERSHAM, MASS., IN 1935[1]

By W. L. BAKER[2] and A. C. CLINE[3]

FOR many years the gypsy moth (*Porthetria dispar* L.) has been recognized as one of the most destructive forest-insect defoliators in the Northeast. Since it first attracted notice in Medford, Mass., 45 years ago, it has spread in all directions until at the present time a considerable portion of New England is infested. In 1923 a "barrier zone" from 25 to 30 miles wide was established in the western part of New England, from the Canadian border to Long Island Sound. In this zone the Bureau of Entomology and Plant Quarantine in cooperation with the New York State Department of Conservation has carried on an intensive eradication program to prevent the insect from spreading westward. A rigid quarantine to prevent the accidental carrying of the insect beyond the known infested areas has also been in effect for many years.

In some years in New England the number of acres defoliated, in varying degrees of intensity, has run into hundreds of thousands. The sections most seriously affected for many years are York and Cumberland Counties in Maine; Rockingham, Strafford, Hillsboro, Merrimack, Belknap, and Carroll Counties in New Hampshire; and Barnstable, Plymouth, and Bristol Counties in Massachusetts. There are, however, large areas east of the barrier zone where the insect has been present for many years but has never reached outbreak numbers. Observations have been made over a sufficient period, and over areas sufficiently large, to indicate that the insect can find conditions favorable for its increase to destructive numbers only in certain types of forest growth. It has long been known that it will thrive on the foliage of some species of trees, and will die where confined to the foliage of others. About 20 years ago data on feeding habits were collected and formed the basis for a table showing the various species of trees, grouped according to preference.[4]

Furthermore, the preference for certain types of foliage is not constant for all the larval instars. For example, oak foliage is desirable throughout the entire larval period, maple is not favored in any instar but will be fed on in the absence of more favored food, white pine is refused by the early instars but is very palatable to the larger larvae, while ash is refused by all instars. In cases of heavy defoliation in mixed stands composed of both favored and unfavored species, where there is sufficient favored food for the larvae to develop through the earlier instars the unfavored species are sometimes completely defoliated by the older larvae. This has given rise to the belief that any and all species are favored. The fact is that, unless some of the highly favored species are present in or near a stand of less favored species, no appreciable feeding on the latter will result. In New England those species highly favored by larvae of all ages are the oaks, poplar, gray birch, alder, willow, and apple.

The purpose of the present investiga-

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[1]Paper presented before the Winter Meeting of the New England Section at Boston, February 20, 1936.

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[3]Assistant Director, Harvard Forest.

[4]Mosher, F. H. Food plants of the gypsy moth in America. U. S. Dept. Agr. Bull. 250, 39 pp., illus. 1915.

tion was twofold: (1) to study the reactions of the insect to its food supply in an area never before heavily defoliated, in order to determine whether it had increased to outbreak numbers irrespective of food plants, or only in concentrations of favored food; and (2) to determine to what extent any discriminating food habits of the insect that might be discovered would permit the application of silvicultural measures of control in a particular locality.

Data bearing on this phase of the gypsy moth problem have been obtained over a number of years. In 1917 Clement and Munro[5] concluded that control could be effected by the removal of all the highly favored species from a stand. It was suspected then that the removal of only a portion of the favored trees would prevent injurious defoliation, but at that time there was not sufficient evidence to warrant definite recommendations. Much of the information that has been made available more recently was obtained from a large number of $^1/_5$-acre sample plots, established by the Federal Gypsy Moth Laboratory in 1911-12, distributed from southeastern Massachusetts to south-central New Hampshire and southwestern Maine and representative of a great variety of forest-cover types. Each tree over 3 inches in diameter breast high was individually observed and recorded by number. At first 264 plots were established, but after 10 years, owing to the death of trees due to defoliation, fire, cutting, etc., the number of useful plots was reduced to 104. Figure 1 shows the relation between the percentage of favored food trees in the plots and the intensity of infestation as measured both by egg masses and by defoliation. It is based on 104 plots and the 10-year period from 1912 to 1921.

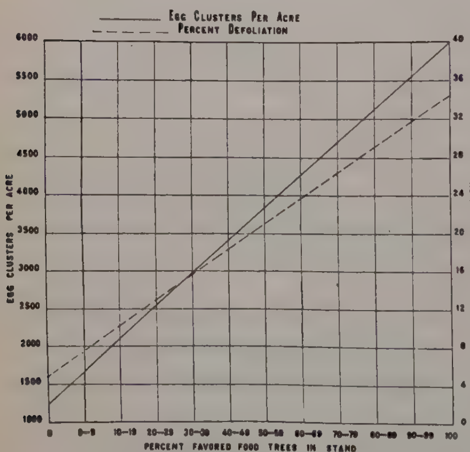

Fig. 1.—The relation between proportion of favored food plants in the stand and intensity of gypsy moth infestation and defoliation. Records from 104 woodland plots in various parts of the infested area in New England for the 10-year period 1912-1921.

This graph shows beyond reasonable doubt that the food supply is a controlling agent of the gypsy moth. The importance of this cannot be overemphasized. For one thing, it means that an enormous amount of mixed woodland growth may be infested but not seriously injured, and that it should be unnecessary to remove all favored food trees in such mixed growth to bring about adequate control.

Study of Outbreak at Petersham

Since silvicultural practice, as well as forest-cover type, varies in different localities, it is desirable from a forest-management standpoint to make intensive local observations, to serve as a basis for specific cutting plans for stand improvement. An exceptional opportunity for making such observations was offered in central Massachusetts in 1935, when the first epidemic outbreak of the insect occurred in that section.

[5]Clement, G. E., and Willis Munro. Control of the gypsy moth by forest management. U. S. Dept. Agr. Bull. 484, 54 pp., 1917.

Petersham was selected as the town for study, first because of its location with respect to the 1935 outbreak, and second because the Harvard Forest was situated within its boundaries. The study was started independently by the Harvard Forest, and concluded as a cooperative project of that institution and the Bureau of Entomology and Plant Quarantine.

Petersham proved to be an ideal town for studying the outbreaks, because of the nature of its forested land and its hilly terrain. It is characteristic of a considerable portion of north-central Massachusetts and the neighboring towns of southern New Hampshire. The rolling nature of the countryside made it possible to see every heavily defoliated (browned)[6] area in the town from one vantage point or another. Land history was such that many contrasting cover types were present, temporary as well as permanent, numerous small stands of favored food trees being intermingled with stands of strikingly different composition. A forest type map of the town, which covers about 22,000 acres, would show approximately 5,000 separate stands.

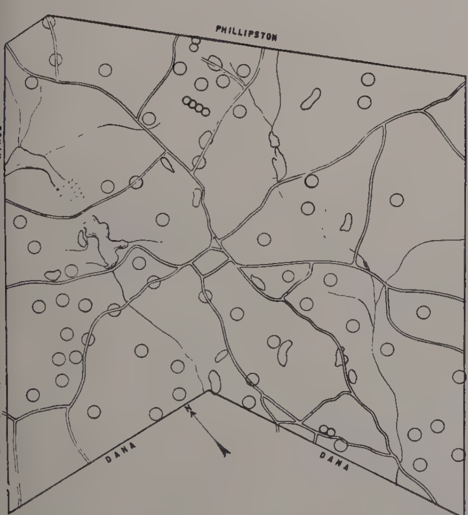

Fig. 2.—Areas in Petersham, Mass., defoliated by the gypsy moth in 1935.

The defoliated areas were located and plotted on a topographic map. (Fig. 2.) There were 82 such areas, and 81 of these were visited and studied by the authors. During the course of travel to and from these areas constant watch was kept for gypsy moth larvae, and invariably some were found wherever favored food trees were growing. This indicated that the insect was generally present throughout the entire town, although complete or nearly complete defoliation of the favored food occurred only in the 82 areas.

In these areas the stand composition and the average percentage defoliation of all species were determined by ocular estimation. It was impossible, and unnecessary from a practical standpoint, to measure these factors precisely, because the study had to be made within the 2-week period when defoliation was at its maximum and refoliation had not begun.

TABLE 1

OCCURRENCE OF CERTAIN TREE SPECIES IN HEAVILY DEFOLIATED AREAS IN THE TOWN OF PETERSHAM, 1935

Species or combinations of species in stand	Number of cases where species comprised indicated percentage range of stand		
	50-75 per cent	75-100 per cent	50-100 per cent
White oak	0	0	0
Red oak	2	0	2
Poplar (2 species)	8	4	12
Gray birch	13	21	34
Gray birch and poplar	18	39	57
Gray birch, oaks, and poplar	20	56	76
Gray birch, oaks, poplar, and alder	—	—	81

[6]Although certain individual trees in these areas, primarily those unfavored as food for the gypsy moth, were not completely defoliated, the general effect was a severe browning. From a distance such browned areas were strikingly different in appearance from their greener surroundings.

The data obtained from these areas are summarized in Table 1. They show that heavy defoliation was invariably associated with a high percentage of favored food trees in the stand.

The results show conclusively that concentrations of species favored as food by all larval instars accounted for the conspicuous defoliated areas in the town of Petersham. Complete defoliation was not observed in any instance where favored food trees constituted less than 50 per cent of the stand. In 56 out of the 81 defoliated areas oak, gray birch, and poplar comprised more than 75 per cent of the stand, thus showing the importance of these three species in creating a suitable environment for the gypsy moth.

Invariably it was observed that the heavy defoliation was limited to stands or portions of stands composed wholly or largely of favored food trees, and that it ceased abruptly with changes in composition of adjoining stands. In addition to the information from the 81 defoliated areas, data were also obtained from the lightly defoliated margins of some of the adjoining stands. A comparison of composition and defoliation under the two conditions is shown for 12 cases in Table 2. Marked differences in composition are at once evident. Favored food trees comprised an average of 89.5 per cent of the defoliated stands, but only 19.3 per cent of the margin of the adjoining stands. The little defoliation that occurred in the latter was limited to a narrow margin, evidently due largely to migrants from the defoliated stand of favored trees. In several cases where narrow strips of unfavored species separated heavily defoliated stands of favored species, the former showed only a trace of feeding—further proof of the discriminating feeding habits of the moth.

Recommendations for Control Program

The findings of this study in the Petersham area, taken into consideration with defoliation records and experiments on host preference over a period of years, warrant the following specific recommendations for the control of the gypsy moth

Table 2

COMPARISON OF DEFOLIATED STANDS WITH THE MARGINS OF ADJOINING STANDS

	Average percentage of favored foods		Average percentage of defoliation					
			Favored food		Unfavored food		All trees	
Plot No.	Defoliated area	Margin of adjoining stand	Defoliated area	Margin of adjoining stand[1]	Defoliated area	Margin of adjoining stand	Defoliated area	Margin of adjoining stand
11	86	12	87	33	37	5	80	9
16	86	21	91	91	58	11	86	28
24	87	15	100	24	54	6	94	8
38	92	19	100	10	47	0	96	2
39	95	1	100	0	100	0	100	0
40	97	32	85	44	75	6	84	18
41B (NE)	91	10	99	36	50	17	95	19
41B (W)	91	16	99	37	50	15	95	17
42	90	51	96	26	34	3	90	14
51	91	35	100	14	72	9	98	11
71	83	5	100	100	54	11	92	15
72	87	15	87	8	55	5	83	6
Mean	89.7	19.3	95.3	35.3	57.2	7.3	91.1	12.2

[1]In certain plots, notably nos. 16 and 71, where favored food trees in the margins of adjoining stands suffered heavily from defoliation, it was due to scarcity of these trees in the composition and their greater occurrence at the extreme edge of the margin next to the defoliated area.

through a program of silvicultural treatment, where conditions are similar to those in Petersham.

Coniferous Plantations.—As previously stated, the older larvae find coniferous foliage a desirable food. Since conifers, with the exception of larch, lack the ability to refoliate following complete defoliation, and since plantations represent a comparatively large investment in new growing stock, the protection of plantations of conifers is placed first on the list of priorities in treatment.

In Petersham both gray birch and poplar commonly seed into old fields and pastures, either before or after plantations are established. On cut-over lands these species are often supplemented by sprouts of red and white oak. The newly hatched caterpillars are able to develop on any and all of these hardwood species. Following complete defoliation the larvae, if they have reached the third instar, can easily migrate to the conifers and defoliate them. Thorough clearing of the planting site prior to planting and timely weeding thereafter will serve the needs of both silviculture and protection. Severe damage to coniferous plantations is usually due to neglect to weed. Nothing is to be gained in any event by allowing a good plantation to be whipped and suppressed by overtopping hardwoods of little or no value, and not intended as part of the crop. It is true, of course, that a hardwood "filler" has proved advantageous in improving the quality of conifers, but in a properly managed stand such a filler is kept below the conifers and not above. Even so, where it is made up largely of gray birch, it may be advisable to remove it. Loss of quality in the butt log is of less importance than defoliation of the tree.

Underplantings. — Underplanting has been used very little locally, but where it has, conditions are usually favorable for moth attack. This is because gray birch and poplar are among the species commonly thought suitable for an overstory. Here the treatment is plainly one of cutting the birch or poplar overstory, even though it may be furnishing protection to the conifers against the white pine weevil and may be too small to make cordwood. Conifers growing directlv beneath a canopy of favored food trees are liable to be seriously defoliated. At the same time, it is recognized that sudden and complete release from partial suppression may result in damage to the conifers from snow or ice. In some cases releasing may require two steps, the first one reducing favored-food-tree foliage as much as possible without jeopardizing reasonable security against bending and breaking with snow or ice loads, with the final removal cutting a few years later, when the conifers have strengthened their stems sufficiently to withstand the elements.

Coniferous Understories of Natural Origin.—From the standpoint of control, conditions here are much the same as those discussed under "Underplantings". Frequently pine and gray birch seed simultaneously into old fields and pastures, but the birch soon overtops the more slowly growing pine, arrests its growth by whipping off the buds, and in time often completely suppresses it. The obvious treatment is the cutting of the birch before suppression of the pine has reached a critical stage, and before a moth colony becomes established.

Almost without exception, both coniferous plantations and natural coniferous reproduction, whether on old fields or cut-over land, contain more or less weed hardwoods of the favored food species, and their prompt elimination is demanded both as sound silvicultural practice and as a protective measure.

Isolation Strips.—Several cases of defoliation were observed at the margins of coniferous plantations growing next to stands composed wholly or largely of gray birch, poplar, alder, or oak. It is

evident that the removal of favored food trees from within plantations or young coniferous stands of natural origin must be supplemented by cutting a protective strip wherever such hardwoods occupy adjoining areas. On the basis of several observations, it would seem that, under conditions at Petersham, a cleared strip about 100 feet wide should be sufficient to prevent any serious defoliation along the margin of the coniferous stand.

Mixed Stands of Pine and Better Hardwood.—In a few cases noted, some defoliation of pine occurred because of its association with red and white oak. Such mixtures are found on the lighter soils, or on exposed southern slopes and ridge tops. It is not a common condition in Petersham. In middle-aged or maturing stands of this composition, the pines generally were not defoliated to such an extent that they would die, except perhaps where they formed a minor element in the mixture. In some cases, however, defoliation might be severe enough to warrant protective treatment, and this would take the form of a cutting to reduce the quantity of oak foliage. It is believed that a reduction to about one-half that of the pine will assure safety of the latter from heavy defoliation, but further observations are needed on this point. Where conditions of ownership and merchantability warrant the complete elimination of the oak, any sizeable opening made by cutting might be planted to conifers, thus forming a groupwise coniferous mixture of two or more age classes.

On the Harvard Forest, young groupwise mixtures of conifers and better hardwoods, including in some instances a substantial proportion of red oak, may require protective treatment. Since, on the heavy soils where such mixtures are being developed, there is a large variety of hardwoods available for the crop, the treatment will consist of a reduction in the proportion of oak and a corresponding increase in that of such species as white ash, hard maple, and paper birch. This alteration in composition can be done in the course of weedings and improvement cuttings regularly carried out in such stands. It is probable that reduction of oak foliage to somewhat less than half the total for all hardwoods in a given group will afford adequate security to the neighboring coniferous group. Because of the strong tendency of red oak to crowd out other valuable hardwood species, a reduction in the proportion of this species, especially through cutting the coarser individuals, is considered desirable from the standpoints of high-quality crop production and a well-balanced mixture, regardless of its protective value.

Stands of Mixed Better Hardwoods.—With a few exceptions such stands in the town of Petersham fall within the so-called Transition Hardwoods type, which is composed of a considerable variety of commercial species representative of both the Northern Forest and the Central Hardwood Forest. Since the death of chestnut, however, red oak is the most aggressive species in the mixture, and in many stands of middle age or older it predominates to the extent of occupying a larger proportion of the crown canopy than all associated species combined. For the most part the latter are unfavored food species. To avoid recurrent defoliation of the oak, particularly where it occurs in groups, with at least a resultant slowing down in growth, some alteration in stand composition is indicated. Under local conditions it is believed that a reduction in the volume of oak and other favored foliage to an upper limit of one-half of the total for the main canopy will afford satisfactory protection. Depending upon age, density, and relative proportions of favored and unfavored species, such a reduction will require one or more cuttings annually over a period of years. These may well be combined

with the ordinary types of improvement cuttings and thinnings applicable to such stands.

Stands of Favored Weed Species.—Stands of gray birch or poplar, or mixtures of the two, occur commonly throughout the town. As shown in Tables 1 and 2, these provided the chief sources of infestation. Though neither species is sufficiently valuable to warrant much concern over its protection, there are places where the owner may wish to avoid further trouble. Plainly the only possible method of silvicultural control is clear-cutting followed by planting. On the best soils hardwoods of unfavored species or mixtures of such hardwoods and conifers may be used; on the lighter soils, conifers alone. Such complete conversion from weed hardwoods to valuable saw-timber species is, of course, a part of the usual plan of management on the organized forests.

The conditions cited above are the ones commonly found in Petersham. They are by no means representative of the entire region infested by the gypsy moth. It is believed, however, that measures of indirect control through silvicultural treatment must be worked out locally, and that the observations of the past season in this town and the conclusions drawn therefrom contribute toward this end.

A FOREST SEED PROGRAM FOR THE UNITED STATES[1]

By HENRY I. BALDWIN[2] AND HARDY L. SHIRLEY[3]

In the July issue of the JOURNAL the authors of this paper discussed "Forest Seed Control" from the standpoint mainly of what has been done in Europe. Their presentation of the subject is completed in what follows.

THE greatest users of forest tree seed in America are the various federal and state agencies engaged in forest planting for timber production, soil conservation, game food and cover, and shelter from wind. During the past year the federal Forest Service alone planted some 222 million seedlings, and sowed in its nurseries seed for an even larger number. Public agencies have the greatest stake in the question of seed origin, and should take the leadership in a program adequate for their own needs and large enough to cover the requirements of private agencies and foreign purchasers. Private tree planters are less in a position to choose intelligently than the public agencies, and both need and deserve the protection of a strong program, backed by the public. The aggregate amount of tree seed of all kinds used in landscape nurseries and other private work is very considerable. Uniform regulations should apply to all tree seed.

Much had been written of the provenience question before any action took place. It is of little use to limit our consideration of the subject again to mere academic discussion. A few concrete proposals are therefore made. Obviously a perfect solution cannot be found all at once. The following suggestions are believed to be practical and possible of accomplishment at the present time.

BETTER RECORDS OF EXISTING SEED, STOCK, AND PLANTATIONS

It ought to be obvious that no matter how carefully seed is collected and cared for, failure to keep records through the nursery and into the plantations results in losing track of whatever evidence we may have of the importance of provenience, and makes it impossible to benefit from experience. While we may be playing safe, and making as intelligent a selection of seed as possible, so that we may expect good results, there is no check on our results unless records are kept. Even if the origin is unknown, a record should be kept through to the plantation of the dealer from whom the seed was purchased, or as far back as the origin can be traced. More information might turn up later. Where it is possible to state the origin of the seed of existing stock now in nurseries and of plantations, this should be done and put on record without delay. With few exceptions, adequate records have not been kept of the source of seed in the huge area which has been planted in the past. In the face of European evidence of the importance of origin, such omissions are indefensible. Sample record forms have been developed in the Forest Service at the Northeastern Forest Ex-

[1]Read originally before the New York Section, Society of American Foresters, Albany, N. Y., February 1, 1935, by H. I. Baldwin and issued in mimeographed form by the New York Section, 1935. Revised and augmented in cooperation with H. L. Shirley, January, 1936.

[2]Caroline A. Fox Research and Demonstration Forest, Hillsboro, New Hampshire.

[3]Lake States Forest Experiment Station. (Fellow, Oberlaender Trust, 1935.)

periment Station, and may be obtained on application.

Use of Local Seed

Until our forest management becomes more stabilized, it is difficult to collect and extract seed of the species used in reforestation near the planting site, or even from a similar climatic zone. The C.C.C. provides at present, however, an agency which might well explore the possibilities of local collection. Valuable information would be obtained on the best places to collect in each county. Purchases should also be made from local residents, and an effort made to build up a force of collectors who can be counted on year after year. Small portable extraction plants have been tried at various places in Europe. There are many advantages to smaller units for seed extraction, especially where cones must be shipped long distances. American engineering skill has yet to devote serious attention to the construction of an economical seed extractor, simple in design and cheap in first cost and operation. The writers believe there is room for technical improvements in this line. Some work has already been done at the Experiment Stations and at the Forest Products Laboratory.

Insistence on Knowing the Origin of Seed

If seed must be purchased which comes from a distance, it is assumed that a reliable statement of the provenience is given by the collector. This must be insisted on. Dealers will furnish information if purchasers insist upon it. A consumer demand is far more effective than any law. If foresters as a body will stick to their convictions and, whether engaged in public or private work, pledge themselves to purchase or sell only seed of known origin, it is certain to bring results.

Central Forest Seed Laboratory

One of the first requirements for a satisfactory seed certification service is the early establishment of a well-equipped and well-staffed central forest seed laboratory. This laboratory not only can serve to make routine tests of genuineness, purity, and germination of seeds, an essential part of any satisfactory certification service, but also can serve as a center for education, investigation, and leadership in the entire province of forest seed. Methods of collecting, extracting, storing, germinating, and sowing the four or five hundred different species which are being called into use in the entire national program is in itself a stupendous task, which alone would justify the establishment of a central laboratory. Studies of laboratory methods of distinguishing origin of various species is an unexplored field in America, which forms an essential corollary for any certification service.[4] Improvement in methods of packaging and storing seed will greatly simplify the problem of administering a seed certification service. Methods which make possible the keeping of seed for longer periods without loss of viability, and methods which insure securing full germination of the seed sown, all help to reduce the danger of running short of suitable seed. Such a laboratory should well repay its cost through insuring better technique in the entire handling of seeds and better certificates of germination and purity.

In the provenience field the central laboratory would naturally take the leadership in encouraging the establishment

[4]Langlet, O. Om variationen hos tallen (*Pinus silvestris* L.) och dess samband med klimatet. Sv. Skogsvårdsför. Tidsk. 32:87-100. 1934.

of more planting tests, and in collecting and compiling data on climate and other physical factors involved in the success of a given seed source. One of the largest problems in connection with the provenience question is that of learning what climatic factors are most important in determining success, and in preparing data on these factors for the United States in such a way that they will serve as a guide to the intelligent selection of seed. The central laboratory can serve as a clearing house for all information on forest seed, and should prepare from time to time up-to-date handbooks or manuals which present the available data on each species in a concise, usable form. Of first importance is an atlas of different proveniences, the world over, with the chief climatic characteristics of each, in order that the user of seed may have the information on which to base an intelligent selection of seed. Handbooks of this type will be an invaluable aid to nurserymen and others engaged in propagating forest plants.

Intelligent Selection of Seed from Distant Sources

If seed of far-off provenience must be purchased, either because of local crop failure or where exotics are to be planted, it should be chosen from a place as nearly like the planting site in climate as possible. At present it is difficult to do this without adequate climatic maps. We must do the best we can. So far, the mean temperature of the growing season (usually June-September, inclusive) seems to be the best single factor, since it takes account of altitude. Perhaps next in importance is the character of the weather just prior to the beginning and just after the end of the growing season, together with the length of the growing season.[5] Should warm weather in spring be followed by a late frost, species from cold regions and regions with short growing seasons are likely to be injured, whereas species accustomed to a long growing season fail to become hardened before early frosts in colder regions. Mean annual temperature, character and distribution of precipitation, and minimum winter temperature are also important and should be considered. Unusual weather conditions, such as frequency of prolonged droughts, are of great importance in less humid regions; while in the case of certain species the velocity and direction of wind is an important consideration. This information is to be found in some of the more complete atlases on climatology, chiefly European works. It is not always readily available to the nurseryman who must choose his seed from possibly a foreign country.

Study of Plantations for which Records of Seed Origin Are Available

Regional Forest Experiment Stations and other forest agencies should study existing plantations for which records of seed origin are available and keep them under observation to determine the suitability of seed source for the particular locality under consideration. A start on this work has already been made in certain sections of the country, and should be extended. While many plantations are still too young to yield a final answer, cases of pronouncedly bad seed origin show up early, and unless they are investigated promptly the plantation may die out entirely before being examined.

Comprehensive Provenience Experiments

Study of existing plantations should be supplemented by a well-planned series

[5]Enquist, F. Studier över samtidiga växlingar i klimat och växtlighet. Svensk Geografisk Årsbok. 1929.

———. Trädgränsundersökningar Sv. Skogsvårdsför. Tidsk. 31:145-214. 1933.

of test plantings from seed of different origin. Fortunately most Regional Experiment Stations have already undertaken such plantings on a small scale, but the work should be greatly extended to include most of the important commercial species which are likely to show geographic races. Such plantings need not be elaborate, but should cover well the range (altitudinal as well as geographic) of the species tested. Large-scale planting plots are desirable, but most of the test plantings of a single seed origin established in Europe are of less than one-tenth acre in size, and from the study of these small plots much valuable information has accrued.

The availability of C.C.C. labor for seed collecting and planting renders such a program highly feasible at the present time, and since the greatest cost of such experiments is included in their initial establishment, no effort should be spared to extend this work.

Cooperative Voluntary Control

There should be initiated as soon as possible a cooperative voluntary forest seed control system by which certificates of seed origin can be furnished to seed dealers and others desiring them. Active governmental participation will be required to establish confidence in the system in the minds of local seed buyers and to restore the confidence of foreign purchasers in the verity of origin of American forest seed. The operation of the system can be modeled after the voluntary seed control systems in effect in Switzerland and Denmark and the semi-obligatory system in Czechoslovakia, but adapted to American requirements and to existing American organizations. The methods employed for agricultural seed by the Seed Verification Service in the U. S. Department of Agriculture might well be adapted in part to the requirements of forest seed. Much progress can be made towards accurate seed control by the adoption of sealed containers for marketing. Government-labeled containers can be supplied at the time of extraction, and containers need not be opened until the seed is sown.

It cannot be hoped that complete control can be established in a short time, because not even the compulsory system in Germany, with its well-organized forest administrators, can be considered 100 per cent perfect. This is all the more reason for initiating the system at once, while the number of forest-seed dealers is still relatively few, and while they can be convinced more easily of the advantage to be derived from such a service. Unquestionably a seed control service will greatly stimulate export of seed.

Education

All persons purchasing planting stock for reforestation should be warned of the importance of seed source, and acquainted with the facts as far as known. A clear popular exposition of provenience should be distributed by the various extension agencies. This need not in the least discourage people from tree planting; it need not cast any reflections on past planting propaganda, although there is no question in the writers' minds that some of it has been overdone to the neglect of stand improvement and natural reproduction. The neglect to mention more prominently the importance of provenience has been, however, indefensible. Let us not think for a moment that this omission will fail to be noticed, not at once by all planters on private land, but eventually by some. The longer source of seed is not emphasized in our planting literature, the more unfavorably it will reflect upon foresters. It cannot be ignored permanently. Some cases are known where the question has been "soft-pedaled" by editors, extension specialists, and others. Far from advocating any-

thing which might be exaggerated, the writers are convinced that nothing will be gained by withholding information.

Planning Seed Requirements

Seed needs should be planned several years ahead in order to lay in supplies during crop years and avoid last-minute purchases, which so often compel the use of seed of unsuitable origin. This, we are well aware, is not easy to stick to, especially when a public reforestation program undergoes sudden changes, as has occurred throughout America in the last three years. Many factors over which foresters have no control upset the best plans. On the other hand, seed storage facilities, collection organization, and the like are amenable to planning. In connection with seed planning, the matter of seed crop reports might be mentioned. One Forest Experiment Station conducted for several years a crop survey, with reports of conditions. Similar reports were issued by another Station in 1935. Essentially this means hearing from one's collectors in advance of the cone-picking season. Instructions on amount to be gathered of each species may then be issued.

Natural Reproduction Preferred

It would not be fitting to close a plea for vigorous action to avoid the dangers of mixed races in the forest without pointing out the obvious and only real solution to the provenience question: natural reproduction. It is fairly safe to predict that the history of forestry will be repeated in this country and that, as our present plantations mature, more attention will be devoted to reproducing forests naturally, even as is now the trend in the countries where forestry is older. There, earlier widespread exploitation of forests, and continuous cutting of the best and leaving the worst, progressed to a certain point, after which artificial regeneration increased enormously, and has so continued until recently. Seeding and planting are at best expensive and feeble substitutes for natural reproduction, and should be reserved for emergencies such as large burns and areas which have suffered other calamities. The real test of the suitability of seed origin is whether the trees can reproduce in their new homes. Adaptability will finally show up then, no matter how the plantation has resulted otherwise. This test of suitability we are least able to predict. Nature has done a bigger job of adaptation than we can attempt, and our energies should accordingly be directed to perpetuate the best that Nature has already produced for us.

CURRENT STAND IMPROVEMENT PRACTICES AND POLICIES IN THE SOUTHERN APPALACHIAN REGION[1]

The subject of timber stand improvement, particularly as carried out by C.C.C., has been and still is a very live topic. Many criticisms have been made, especially by outside groups, based largely on general observations. The answers that foresters could give have in general been similarly vague. This factual report fills a definite need in sizing up timber stand improvement work and furnishing material for withstanding the attacks of uninformed groups.

IN the territory of the Appalachian Section, the greatest need for stand improvement exists in the mountain and upper Piedmont hardwood types, where a long history of fire and repeated logging has resulted in generally depleted second growth of low quality. In this region the primary purpose of cultural operations is to increase the proportion of desirable timber species in the dominant stand with as little disturbance as possible of those species which are primarily useful for special minor products or game-food values.

In considering its responsibilities your committee decided that its primary function was to determine if this objective was being accomplished by current stand improvement practices, and to recommend such changes as the findings might indicate.

It is obvious that such a program would require more systematic field work than the committee as individuals could accomplish. Therefore the cooperation of those National Forests in our territory with stand improvement programs was solicited. The project was well received by these Forests, and a special form of sample plot field record was devised by the committee and put into use by all stand improvement crews operating during the past winter. Foresters in active charge of cultural operations were required to establish plots ahead of their crews and record all standing trees by species group, diameter, and crown class, and also to indicate on the form those trees which in their opinion should be removed. After the crew had passed over a given plot it was tallied again, the record this time indicating the species group, diameter, and crown class of both the standing and cut or girdled trees. A comparison of estimated with actual performance was therefore made possible. Additional information regarding the site and age class represented by each plot was also recorded. From 5 to 8 of these plots were established as a continuous process during each day's work, and they therefore comprise a roughly random sample of actual treatment, and also provide the means for an approximation of the proportional area of the various sites and age classes of forest in which cultural operations are being carried on. Since an understanding of the various species groups used is essential to interpretation of later discussion, brief definitions are given here. The groups may be described as follows:

1. Species of the highest timber value in the region where stand improvement is active.

2. Species of minor timber value.

3. Special-use and game-food species. This group includes species not usable for saw timber but which in the opinion of the committee are desirable for special small dimension products, or game-food values.

[1]Report by Timber Stand Improvement Committee, Appalachian Section.

4. Other species not considered valuable for any of the above purposes.

The more common species are listed below under each of these four headings:

SPECIES CLASSIFICATION

Desirable Timber Species

Yellow popular	Cucumber	Black cherry
Northern red oak	Shortleaf and pitch pine	Yellow birch
White oak	White pine	Black locust
Basswood	Chestnut oak	Spruce
Hemlock	Sugar maple	
Ash	Walnut	

Less Desirable Timber Species

Scarlet oak	Red maple	Beech
Black oak	Virginia pine	Buckeye
Post oak	Table Mountain pine	Balsam
Southern red oak	Black birch	
Hickory	Butternut	

Special-Use and Game-Food Species

Dogwood	Chinquapin	Crataegus
Holly	Umbrella magnolia	Persimmon
Black gum	Fire cherry	Sumac

Others

Blackjack oak	Silverbell	Ironwood
Sourwood	Blue beech	Sassafras

Records from approximately 700 sample plots were compiled and analyzed by the commitee, and our findings are based primarily upon the results of this work. Information on the current stand improvement program not covered by the sample plot form was obtained through general field observation and by inspection of official records of the U. S. Forest Service.

The outstanding facts developed by our investigation are as follow:

1. In our Section's territory approximately 345,000 acres of National Forest land have been covered by stand improvement operations. This represents 22.5 per cent of the net and 6½ per cent of the gross area of National Forest land.

2. Current operations are confined entirely to Sites I and II. On these sites over one-half of the area being treated is in age classes under 20 years of age, and over three-quarters is in age classes under 40 years of age. Age classes older than 40 years are treated only as they are encountered in small tracts within larger areas of younger stands.

3. Current stand improvement is definitely accomplishing the objective of increasing the number of dominant trees of desirable timber species for those age classes under 40 years of age, and this improvement is most marked in the age classes under 20 years. In the age classes under 40 years, and primarily in those under 20, not only has the number of dominant trees of desirable timber species been increased, but field inspection indicates that the trees of this crown class contain a greater number of individuals of good form than was the case before treatment. A desirable silvicultural result has thus been attained in these younger age classes, and in our opinion there has been definite improvement in their timber-productive possibilities. At the same time, however, there still remains on the ground a large number of overtopped trees of desirable timber species which could be released if the treatment given was more thorough from the silvicultural angle only.

4. In the age classes over 40 years current practice does not achieve so distinct a silvicultural improvement. The

men in the field recognize fully that a heavy cutting in older hardwood stands usually results in the development of epicormic sprouts on residual trees, thus distinctly lowering the quality of the remaining stand.

There is general agreement that insufficient knowledge exists regarding the proper improvement methods to use on these older age classes, and that treatment in such stands should be confined to experimentation.

Increased accessibility by recent construction of many miles of truck trails has resulted in lowering the standards of merchantability of both timber stands and individual trees. The possibilities of harvesting low-grade material have therefore been increased.

For these reasons present operations in older stands are limited almost entirely to groups of trees below 8 inches in diameter which occur under small openings in the dominant forest canopy. Under this system an average of 5 per cent of the trees in the 41-80 year age class and one-half of 1 per cent of the trees in the age classes over 80 years are being removed in treatment. Although some slight improvement is accomplished, silvicultural treatment of the older hardwood age classes is somewhat hazardous due to our present lack of knowledge, and it is recommended that they be passed over without treatment when encountered in the field.

5. As already pointed out, the success of present stand improvement operations is measured not only by the increase in the number of dominant stems of desirable timber species but also by as little reduction as possible in the number of special-use and game-food species. Our figures indicate that next to the species of highest timber value the special-use and game-food group are removed to a lesser extent than are the remaining two species groups. In general the amount of this removal is light. For example, in the age classes under 20 years an average of 19 per cent of the original number of special-use and game-food species is being removed; in the class from 21-40 years, 8 per cent; 41-80 years, 4 per cent, and over 80 years, none. It is apparent therefore that special care is being used to preserve these species, and that they are considered second in importance only to the species of highest timber value.

6. The girdling or cutting of trees of merchantable sizes is restricted to the worst cases of defective and deformed individuals, and is done only where these trees are definitely interfering with the development of desirable young growth. In the age classes under 20 years, where trees of merchantable size are usually the culls left after logging, present cultural operations are removing an average of 39 per cent of the trees over 8 inches in diameter. An average of approximately 20 per cent of the trees above this size are removed in stands from 20 to 40 years of age, and in stands older than 40 years less than 2 per cent of the trees of merchantable size are cut or girdled.

7. Preservation of scenic values plays a definite part in present stand improvement operations. Strips along roads, trails, and major streams are either not treated at all or are given special consideration from the scenic and engineering angle. However, further emphasis is needed on the planning of timber stand improvement operations with reference to future road and trail construction. This is true periodically in areas where a heavy recreational use is expected. Cultural work should be limited to those areas where road and trail development has been completed, since it is only under these conditions that scenic values can be safeguarded.

From the foregoing discussion it is apparent that present cultural methods are tempered by consideration of a variety of

public interests, and that in general a satisfactory compromise has been reached. However, as is usually the case, the compromise is not eminently satisfactory from each of the various viewpoints represented by special interests. For this reason it is essential that as rapidly as possible individual forest areas be classified as to primary value for timber production, public hunting and fishing, and esthetic, ecological, and other purposes.

There is general recognition of this need by all public agencies in the territory, and some progress has been made. However, aggressive pursuit of a program of land classification is essential if public needs are to be anticipated.

With such a classification definitely under way, stand improvement technique can be directed toward more specific objectives.

Before concluding it must be stated that some of the criticism offered in the past was justified. In restricted areas trees were girdled which later became merchantable through increased accessibility. A number of timber sales have resulted in the salvage of some of this timber. In other areas special-use and game-food values were reduced beyond a reasonable necessity during the early part of the program, and scenic values were not given great consideration.

It was perhaps inevitable that the necessity of putting a large army of men to work with insufficient time for adequate training of foremen resulted in some mistakes being made.

It is our conclusion, however, that with the few minor exceptions noted the present stand improvement operations are based on a recognition of the various forest values involved; that they are accomplishing a needed silvicultural improvement on our National Forest lands; but that improvement in specific results is possible and can be accomplished only with a more clear-cut understanding of the primary purposes to which individual forest tracts should be devoted.

W. C. BRANCH,
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RATE OF FORMATION OF HEARTWOOD IN SOUTHERN PINES

By E. L. DEMMON

Southern Forest Experiment Station

In a paper presented at the annual meeting of the Society of American Foresters at Atlanta, Ga., on January 27, 1936 (2), the effect of heartwood in the production of newsprint from southern pines was stated as follows: "Where heartwood is present in small quantities, it does not seriously interfere in newsprint production by the ordinary groundwood-sulphite process. However, if heartwood makes up a considerable proportion of the pulpwood volume, the manufacturing processes involved are more difficult to adjust."

Although data on the rate of formation of heartwood were presented on a chart at the time the paper was delivered, some revisions were necessary for publication purposes. These have been made, and the data presented in Figure 1 summarize information on rate of heartwood formation, by volume, for the four principal species of southern pine.

It is recognized that the number of trees studied do not represent an adequate basis for any final statement on the subject, but the trends indicated are sufficient for general purposes of discussion. The data presented in Figure 1 were obtained in some preliminary studies of longleaf pine in Florida by the Southern Forest Experiment Station; in two separate studies conducted by the Forest Products Laboratory, of Madison, Wis., on shortleaf pine in Arkansas (1) and on slash pine in Florida (4); and in an investigation of loblolly pine in Virginia, North Carolina, and South Carolina, by

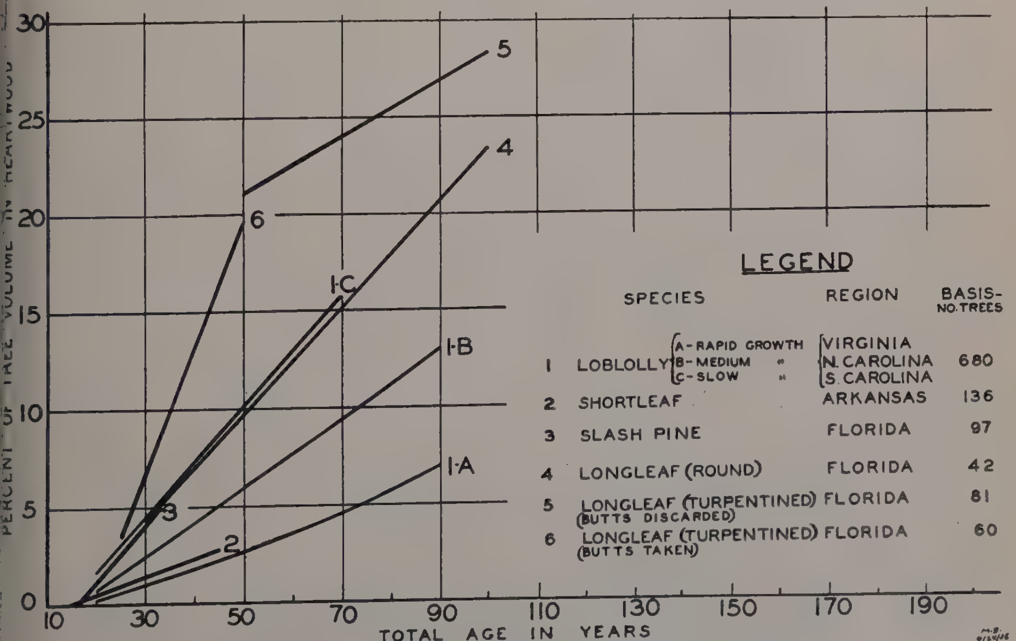

Fig. 1.—Rate of formation of heartwood in southern pines.

the Appalachian Forest Experiment Station.

The following brief conclusions can be drawn:

1. The formation of heartwood in southern pines does not begin until the trees are 15 to 20 years of age.

2. Shortleaf and loblolly pines, on the average, contain much smaller proportions of heartwood, for similar aged trees, than do longleaf and slash pines.

3. The proportion of heartwood (in loblolly pine) varies with rate of growth, the more rapidly growing trees containing smaller proportions of heartwood.

4. Turpentining tends to increase the proportionate volume of heartwood. In longleaf pine, this increase amounts to 5 to 10 per cent by volume.

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A CUBIC VOLUME TABLE FOR EASTERN RED CEDAR

By WILLIAM MAUGHAN

Duke Forest, Duke University

EASTERN red cedar (*Juniperus virginiana* L.) occurs throughout a wide range in the eastern United States and is of commercial importance in many parts of its range. However, so far as the writer is informed, no reliable volume tables are available for this species. It is found in nearly every stand in the Duke Forest, and in some stands becomes an important component species. The lack of reliable volume tables caused considerable inconvenience when the original inventory of the Forest was made, and has been a handicap in much subsequent work. Consequently stem analyses were recently made on 107 trees selected at random from 16 stands scattered over most of the soil types found in the Duke Forest.

The first table, showing volumes in cubic feet, constructed from these data is presented herewith, with the idea that it will be useful in the absence of other tables. Even though the data were collected in one locality, it is believed that forest conditions, particularly those affecting the tree form of red cedar, are quite comparable over a large area on the Piedmont plateau, and that the table can be applied with a fair degree of reliability in most of the Middle Atlantic Piedmont. Additional copies of this table are available and may be obtained upon request.

Since red cedar does not ordinarily attain very large sizes, it is believed that, to be most useful, a cubic table for this species should show volumes for smaller intervals of diameter and height than are given in the ordinary tables. Consequently this table has been set up on one-half-inch diameter classes and 5-foot height classes. If volumes for trees falling between the tabulated classes are desired, they can readily be obtained by interpolation to a degree of accuracy satisfactory for most uses. If either extreme accuracy or volumes for trees not already shown are desired, the equation given below should be solved for each individual diameter and height.

The table was constructed by the logarithmic regression equation method suggested by Schumacher and Hall.[1] For this table the equation is: Logarithm of total volume, inside bark = 1.7983 (logarithm of diameter breast high, outside bark, in inches) + 1.0802 (logarithm of total height, in feet) — 2.5646. For example: to find the volume of a tree 8.5 inches in diameter and 40.0 feet in height:

$$\text{Logarithm of } 8.5 = .9294$$
$$\text{Logarithm of } 40.0 = 1.60206$$
$$\text{Log. volume i.b.} = 1.7983\ (.9294) + 1.0802\ (1.60206) - 2.5646$$
$$\text{Log. volume i.b.} = 1.6713 + 1.7305 - 2.5646$$
$$\text{Log. volume i.b.} = .8372$$
$$\text{Volume in cu. ft.} = 6.87$$

[1]Schumacher, F. X. and F. D. S. Hall. Logarithmic expression of timber-tree volume, Jour. Agri. Research 47: 719-734. 1933.

The writer is indebted to A. L. MacKinney and L. E. Chaiken of the Appalachian Forest Experiment Station for their advice and assistance in the statistical work involved in the construction of this table.

Cubic Volume Table For Eastern Red Cedar (*Juniperus virginiana* L.) in the Duke Forest

D.b.h. o.b.	15	20	25	30	35	40	45	50	55	60	65	70	Number of trees
	Total height in feet / Volume in cubic feet (inside bark)												
2.0	0.18	0.24	0.31	0.37	—	—	—	—	—	—	—	—	—
2.5	0.26	0.36	0.46	0.56	0.66	—	—	—	—	—	—	—	1
3.0	0.37	0.50	0.64	0.77	0.91	1.06	1.20	—	—	—	—	—	4
3.5	0.48	0.66	0.84	1.02	1.21	1.39	1.58	1.77	—	—	—	—	5
4.0	—	0.84	1.07	1.30	1.53	1.77	2.01	2.26	—	—	—	—	7
4.5	—	1.04	1.32	1.61	1.90	2.19	2.49	2.79	—	—	—	—	4
5.0	—	1.25	1.59	1.94	2.29	2.65	3.01	3.37	—	—	—	—	10
5.5	—	1.49	1.89	2.30	2.72	3.14	3.57	4.00	—	—	—	—	5
6.0	—	1.74	2.21	2.69	3.18	3.67	4.17	4.68	5.18	—	—	—	9
6.5	—	—	2.56	3.11	3.67	4.24	4.82	5.40	5.99	—	—	—	6
7.0	—	—	2.92	3.55	4.20	4.85	5.51	6.17	6.84	7.51	—	—	10
7.5	—	—	3.30	4.02	4.75	5.49	6.23	6.99	7.74	8.51	9.27	—	4
8.0	—	—	3.71	4.52	5.34	6.17	7.00	7.84	8.70	9.55	10.4	—	6
8.5	—	—	4.14	5.04	5.95	6.87	7.81	8.75	9.70	10.7	11.6	—	4
9.0	—	—	—	5.58	6.60	7.62	8.65	9.70	10.7	11.8	12.9	—	7
9.5	—	—	—	6.15	7.27	8.40	9.54	10.7	11.8	13.0	14.2	15.4	4
10.0	—	—	—	6.75	7.97	9.21	10.5	11.8	13.0	14.3	15.6	16.9	3
10.5	—	—	—	7.37	8.70	10.1	11.4	12.8	14.2	15.6	17.0	18.4	5
11.0	—	—	—	8.01	9.46	10.9	12.4	13.9	15.4	16.9	18.5	20.0	2
11.5	—	—	—	—	10.3	11.8	13.5	15.1	16.7	18.4	20.0	21.7	3
12.0	—	—	—	—	11.1	12.8	14.5	16.3	18.0	19.8	21.6	23.4	2
12.5	—	—	—	—	11.9	13.8	15.6	17.5	19.4	21.3	23.2	25.2	2
13.0	—	—	—	—	12.8	14.8	16.8	18.8	20.8	22.9	24.9	27.0	2
13.5	—	—	—	—	—	15.8	17.9	20.1	22.3	24.5	26.7	28.9	—
14.0	—	—	—	—	—	16.9	19.2	21.5	23.8	26.1	28.5	30.9	1
14.5	—	—	—	—	—	18.0	20.4	22.9	25.3	27.8	30.4	32.9	1
15.0	—	—	—	—	—	19.1	21.7	24.3	26.9	29.6	32.3	35.0	—
15.5	—	—	—	—	—	—	23.0	25.8	28.6	31.4	34.2	37.1	—
16.0	—	—	—	—	—	—	24.4	27.3	30.3	33.2	36.2	39.3	—
No. trees	—	—	10	17	22	18	21	10	6	2	1	—	107

Blocks indicate extent of basic data. Basis: 107 trees from 16 stands in the Duke Forest. Total volume of stump, stem, and top, inside bark. Stump height = 0.5 foot, measured as a cylinder. Volumes computed through Smalian's formula. Table constructed from logarithmic regression equation: Log. total vol. inside bark = 1.7983 (log. d.b.h. o.b. inches) + 1.0802 (log. total height feet) — 2.5646. Standard error of estimate = ±7.98 per cent.

AIR TEMPERATURE IN RELATION TO FIRE COST AND DAMAGE

By LESLIE G. GRAY[1]

U. S. Weather Bureau

This paper develops an interesting relationship between long-time temperature trends and fire data, based on Forest Service and carefully selected Weather Bureau records. It is written from the point of view of the meteorologist rather than the professional forester, and represents one phase only of considerable painstaking work in which the author has engaged through his own initiative and interest in the forest fire problem. He makes no claim for application of his meteorological analyses beyond the California conditions which they represent.

FIRE control is largely an economic problem to the forest administrator, although its technical aspects also loom large. The administrator must estimate in advance the funds required for suitable protection, he must see to the effective expenditure of available moneys, and he must justify excessively large expenditures in bad fire seasons and conserve public funds in good ones. His aim is to hold control costs to an economic minimum compatible with the adopted protection standard. Number of fires and burned area concern him also, of course, but these factors eventually are reflected in suppression cost and damage data, and the latter will serve adequately as measures of the magnitude of his fire problem.

Every forester recognizes the important part played by weather conditions in the problem of fire control. Hot, dry, and windy conditions will affect control adversely, while cool, moist, and calm conditions will favor easy control. Fire behavior is influenced importantly by numerous weather factors, among which are precipitation, relative humidity, evaporation, wind, and temperature. So far as weather conditions are concerned, the behavior of any given fire represents the net resultant effect produced by numerous individual factors.

However, it is extremely difficult in practice to isolate each factor thus complexly interwoven with others, and, as a consequence, it has been the general practice in fire research to attempt partial corrleations between fire data and individual weather factors. This is, of course, a temporary expedient until methods and data permit more precise evaluations by forms of multiple correlation. Past partial correlations of air temperature with fire data have not been very satisfactory, and have led to the belief that temperature is of no great consequence as a factor affecting fire behavior.

It has been found in a prior study[2] that precipitation and wind velocity data correlate best with long-time trends in area burned; that number of fires does not correlate well with any single weather factor over similar long time periods, but compares best with relative humidity; and that temperature apparently bears a direct relationship to suppression cost and damage data. The object of this paper is to develop the latter relationship in some detail. The foregoing statements refer to long time periods and to California conditions only.

Relative humidity is recognized widely as fundamentally important in day-to-day fire control, through its influences on fuel moisture content. The latter is controlled largely by evaporation losses in re-

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[1] Fire Weather Official, San Francisco, Calif.

[2] Gray, L. G. Long-period fluctuations of some meteorological elements in relation to California forest fire problems. Monthly Weather Rev. 62:231-235, 1934.

lation to precipitation and absorption gains. Evaporation in turn is the resultant of a number of factors, chiefly temperature, relative humidity, and wind. It has been customary to regard relative humidity as the best single weather factor serving as an index of fuel moisture content and fire behavior, aside from direct precipitation or the fire-spreading effect of wind.

It is very questionable, now that the first period of rough approximations in weather and fire relationships is nearing its close, whether we should continue to place so much emphasis on a single factor such as relative humidity or wind. We should henceforth attempt to arrive at fundamental relationships which take account of all pertinent factors, and attempt to assign correct relative weights to each, rather than to adopt a single one as a fetish. It is only through a complete picture that we eventually shall be able to reduce fire control to something approximating a science.

While relative humidity has served and will continue to serve as a helpful practical index of fire danger, it may be pointed out that temperature is a fundamental control of relative humidity, usually bears an inverse relationship to it, and also is related fundamentally to evaporation, precipitation, and wind. Meteorologically, it is generally true that temperature is more intimately related to a larger number of vital weather factors affecting fire than is relative humidity or any other single weather factor.

The whole process of combustion is basically related to temperature, as is evidenced by such things as the heat required to drive off fuel moisture, the ignition temperature, the heat produced by combustion, the effect of wind in removing heat units from a fire, the influences of radiation, convection, and conduction of heat on fire behavior, and the effect of heat in changing the relative amounts of oxygen available for outdoor combustion in given cases. It appears that the greater variability of relative humidity, precipitation, and other factors in comparison with air temperature militates somewhat against close fire correlation over extended time periods. These other factors, however, do correlate better than temperature over short time periods, so far as available studies indicate. When considering long-time trends, the stability of temperature data is readily apparent.

Weather records used in this paper apply to the 27-year period from 1908 to 1934, inclusive. They are for first-order Weather Bureau stations and for cooperative stations selected for apparent reliability and representativeness. Some changes in elevations of thermometers at Weather Bureau stations were made during the earlier record, but most of the heavily populated cities where such changes were most common are so located (near the Coast) as to have little weight in the composite means. The cooperative stations probably have been influenced by the growth of towns in which they are located, but for the most part they represent rural type exposures and substantiate the trends at city stations.

The fire records cover the same time period, and represent data for all National Forests in the California Region (R-5) combined. They were supplied by the U. S. Forest Service, San Francisco, and relate to the permanent fire control organization only. Some changes in cost and damage reporting have occurred, and greater amounts have been available for fire control in recent years. Detailed information regarding the backgrounds of the fire records was not available to the writer, and it has been necessary to assume that they are substantially uniform, systematic, and reliable. It may be felt, however, that these data are misleading, in view of fluctuating commodity values, errors of determination, or changes in protection or statistical policies. Reduction of the data to a given value level through the use of index numbers or other adjustments might give more consistent

results. However, data for making such adjustments are lacking, and for the purposes of this paper it was felt that more or less compensating errors would occur over the 27 years for an area as large as California. Hence no adjustments have been made.

Changes in financial policy and the play afforded to human judgment and inclination in fire control obviously would affect suppression costs more than damage. The latter is considered to be more basic and more nearly to reflect natural conditions. Naturally, more effective suppression efforts will reduce damage, but it seems to be a fair conclusion that protection organizations have always tried to obtain the best fire control possible with the resources available, and no evaluation of suppression effectiveness has been attempted.

Both fire and temperature data are shown graphically in Figure 1 by the method of accumulated departures from average, since this method is especially advantageous for showing general trends with reference to normal. If conditions each year were normal, then the values would all fall on the single horizontal zero or average line. Where the graph lines slope downward and to the right, departures below normal or average are indicated; the steepness of slope is related directly to the magnitude of departures. Horizontal portions of the graph lines indicate no departures, and lines sloping upward and to the right indicate departures above normal or average. Successive annual departures are added algebraically to secure the continuous accumulation. Many types of data, otherwise recalcitrant, yield readily to analysis by this method.

Fire data shown are for all California National Forests combined, for each fire season. Temperature data are composite weighted annual means for 11 selected Weather Bureau stations. Check computations of means for this station group and another group of 11 selected cooperative stations, using both a weighting system and simple arithmetical means, led to practically identical results. The weighted means for Weather Bureau stations, with weights assigned by judgment as to the proportional part of the state area represented by each station in the group, show a little better correlation than the others. The temperature data in detail appear in Table 1 and fire data in Table 2.

Figure 2 shows fire and temperature data plotted simultaneously by actual values instead of accumulated departures. The material variation in cost and damage figures after 1923 may be due in part to variations in funds available, protec-

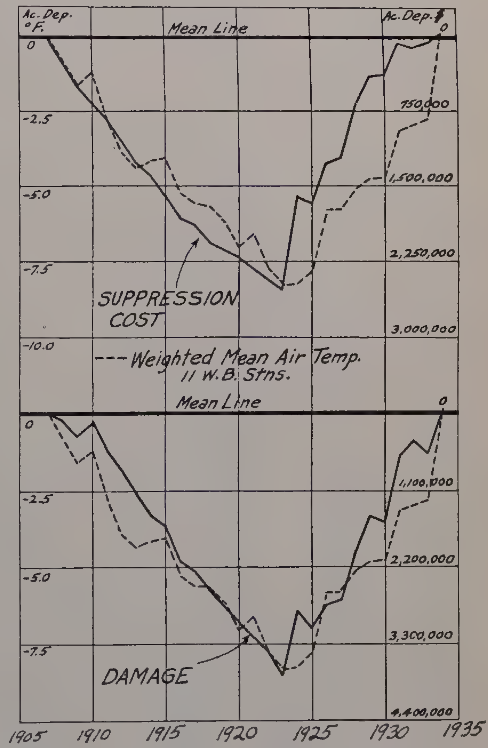

Fig. 1.—Accumulated departures from average (1908-34) of annual mean air temperatures for selected California Weather Bureau Stations (combined) in comparison with accumulated departures of annual forest fire suppression costs and damage in California National Forests (combined) for the same years. Average accumulation of suppression cost per degree accumulation of air temperature, 1908-34, $303,163; same, damage, $444,109.

tion policy, or statistical practice, but may also justifiably be considered largely as a reflection of the much more serious weather conditions in the period 1924-34 than in the period 1908-23.[3]

Although more money was available for suppression after 1923, departures of damage above average continued. If the damage figures were materially influenced by other than natural weather conditions, tending to a natural value based on such conditions and the assumption that suppression effort was effective to the limit of available resources, then they should have been reduced in proportion to the increased suppression funds available. That they continue to bear about the same relation to suppression costs is evidence of the influence of weather and that conditions necessitated increased suppression funds, rather than that the availability of such funds was merely a matter of unusually generous allotments.

The period 1924-34 had an average annual precipitation of about 5 inches less than the earlier period, a mean annual

TABLE 1

CALIFORNIA AIR TEMPERATURE DATA, ANNUAL MEANS, 1908-34

Year	Weather Bureau Stations[1] Wtd. means	Arith. means	Wtd. dep.	Acc. dep.	Cooperative Stations[2] Wtd. means	Arith. means	Wtd. dep.	Acc. dep.
1908	57.11	57.64	— .79	— .79	56.04	56.35	— .97	— .97
1909	57.12	57.60	— .78	—1.57	55.87	56.38	—1.14	—2.11
1910	58.31	58.65	+ .41	—1.16	57.88	57.97	+ .87	—1.24
1911	56.25	57.00	—1.65	—2.81	55.42	55.99	—1.59	—2.83
1912	56.74	57.66	—1.16	—3.97	55.78	56.38	—1.23	—4.06
1913	57.42	58.04	— .48	—4.45	56.68	56.97	— .33	—4.39
1914	58.14	58.92	+ .24	—4.21	57.16	57.61	+ .15	—4.24
1915	58.07	58.78	+ .17	—4.04	57.06	57.46	+ .05	—4.19
1916	56.55	57.29	—1.35	—5.39	55.97	56.32	—1.04	—5.23
1917	57.70	58.29	— .20	—5.59	56.53	56.93	— .48	—5.71
1918	57.87	58.70	— .03	—5.62	57.15	57.69	+ .14	—5.57
1919	57.36	58.05	— .54	—6.16	56.72	57.12	— .29	—5.86
1920	57.03	57.75	— .87	—7.03	56.44	56.90	— .57	—6.43
1921	58.33	58.87	+ .42	—6.60	57.49	57.72	+ .48	—5.95
1922	56.67	57.55	—1.23	—7.83	55.89	56.45	—1.12	—7.07
1923	57.31	58.34	— .59	—8.42	56.12	56.69	— .89	—7.96
1924	57.96	58.60	+ .06	—8.36	56.73	57.27	— .28	—8.24
1925	58.34	59.21	+ .44	—7.92	57.09	57.54	+ .08	—8.16
1926	59.94	60.63	+2.04	—5.88	58.77	58.93	+1.76	—6.40
1927	57.91	58.71	+ .01	—5.87	56.69	57.15	— .32	—6.72
1928	58.68	59.26	+ .78	—5.09	57.80	57.92	+ .79	—5.93
1929	58.12	58.78	+ .22	—4.87	57.47	57.65	+ .46	—5.47
1930	57.88	58.73	— .02	—4.89	57.57	57.78	+ .56	—4.91
1931	59.64	60.35	+1.74	—3.15	58.71	59.05	+1.70	—3.21
1932	58.05	58.64	+ .15	—3.00	57.67	57.79	+ .66	—2.55
1933	58.01	58.37	+ .11	—2.89	57.08	57.04	+ .07	—2.48
1934	60.83	61.51	+2.93	+ .04	59.57	59.82	+2.56	+ .08
Means	57.90	58.58			57.01	57.37		

[1]Stations and weights used: Eureka 3; Fresno 6; Los Angeles 3; Red Bluff 8; Reno 10; Roseburg 3; Sacramento 6; San Diego 2; San Francisco 1; Winnemucca 5; Yuma 3.

[2]Stations and weights used: Crescent City (near) 3; Lemon Cove 6; Santa Barbara 2; Chico 8; Cedarville 10; Montague 3; Stockton No. 2, 6; Escondido No. 2, 3; Pt. Reyes 1; Lake Spaulding 5; Blythe 3.

Minor interpolations were made for both groups of stations to complete the record for the entire 27 years. Data for Weather Bureau stations from annual reports of the Chief, U. S. Weather Bureau, and for cooperative stations from original records on Form 1009. Departures given are from 27-year means; accumulated departures are ordinary departures carried forward algebraically.

[3]Gray, L. C. Loc., cit.

temperature 1.3 degrees higher, and a mean annual relative humidity of about 3 per cent less. These may seem to be comparatively small values, but are of major importance when considered cumulatively over a series of years. For example, the 5-inch precipitation deficiency would amount to more than two and one-half times the average annual precipitation for the state if accumulated from 1924 to 1934.

Another reason for great variability after 1923 (as shown in Figure 2) is an arithmetical one; that is, larger variations are possible with a high-value level than with a low one. The fact that individual seasons do not in all cases show direct correspondence between temperature and fire data is due to the influences of factors other than temperature. For example, the 1924, 1929, and 1931 seasons were characterized by especially deficient precipitation; 1924 was the worst year of record in California since 1864. It may be emphasized again that temperature data show stable cumulative trends over long time periods not evident from other data, but do not necessarily correlate well for short periods because of other influences.

Figure 1 shows the data plotted by accumulated departures from the 27-year averages, and clearly brings out the general cumulative trends. It is seen that temperature and damage compare better than temperature and suppression costs. As has been pointed out, the latter may be influenced to a larger extent by human agency. The consistent long-time cumula-

TABLE 2

CALIFORNIA NATIONAL FOREST FIRE DATA, 1908-34

(Supplied by U. S. Forest Service, San Francisco, Calif.)

Year	Suppression cost[1] Amount	Suppression cost[1] Departure	Suppression cost[1] Accumulated	Damage[1] Amount	Damage[1] Departure	Damage[1] Accumulated
1908	$ 22,225	—244,986	— 244,986	$ 268,067	— 90,948	— 90,948
1909	24,029	—243,182	— 488,168	97,703	—261,312	— 352,260
1910	97,668	—169,543	— 657,711	522,429	+163,414	— 188,846
1911	68,185	—199,026	— 856,737	58,756	—300,259	— 489,105
1912	31,230	—235,981	—1,092,718	8,252	—350,763	— 839,868
1913	82,916	—184,295	—1,277,013	35,733	—323,282	—1,163,150
1914	144,533	—122,678	—1,399,691	61,057	—297,958	—1,461,108
1915	61,057	—206.154	—1,605,845	26,059	—332,956	—1,794,064
1916	61,353	—205,858	—1,811,703	27,548	—331,467	—2,125,531
1917	159,409	—107,802	—1,919,505	224,014	—135,001	—2,260,532
1918	128,692	—138,519	—2,058,024	94.666	—264,349	—2,524,881
1919	203,973	— 63,238	—2,121,262	147,537	—211,478	—2,736,359
1920	159,535	—107,676	—2,228,938	177,967	—181,048	—2,917,407
1921	137,264	—129,947	—2,358,885	34,443	—324,572	—3,241,979
1922	189,008	— 78,203	—2,437,088	188,646	—170,369	—3,412,348
1923	151,666	—115,545	—2,552,633	31,965	—327,050	—3,739,398
1924	1,191,271	+924,060	—1,628,573	1,251,911	+892,896	—2,846,502
1925	207,929	— 59,282	—1,687,855	102,100	—256,915	—3,103,417
1926	675,658	+408,447	—1,279,408	670,352	+311,337	—2,792,080
1927	289,926	+ 22,715	—1,256,693	485,108	+126,093	—2,665,987
1928	829,997	+562,786	— 693,907	1,041,534	+682,519	—1,983,468
1929	536,760	+269,549	— 424,358	935,745	+576,730	—1,406,738
1930	272,620	+ 5,409	— 418,949	183,828	—175,187	—1,581,925
1931	639,443	+372,232	— 46,717	1,331,506	+972,491	— 609,434
1932	423.739	+156,528	+ 109,811	552,646	+193,631	— 415,803
1933	97,569	—169,642	— 59,831	198,437	—160,578	— 576,381
1934	327,043	+ 59,832	+ 1	935,404	+576,389	+ 8
Sums	7,214,698			9,693,413		
Means	267,211			359,015		

[1]Annual, for all National Forests in California combined. Departures are from 27-year averages; accumulated departures are ordinary departures added algebraically.

tive trends of both fire and temperature data are noteworthy. Note also that if the "surprise" year of 1924, unprecedentedly bad from the weather viewpoint since the start of organized fire control, be eliminated from the suppression cost accumulation, the correspondence with air temperature becomes practically as close as that of the damage accumulation.

This partial correlation presents a general picture that may be used advantageously (with other relationships) by the forest administrator for comparing time periods, places, and administrative units in relation to fire occurrence and protection organization performance, and is of interest to the meteorologist from the climatic viewpoint and possible applications to long-range estimates of the character of given fire seasons. Such comparisons of past conditions for economic analysis are useful even though preseason forecasts are not attempted or are not feasible. This partial relationship is not offered as a substitute for other fire and weather relationships, nor does it materially simplify the inherently complex picture of weather and fires. It does, however, bring out forcibly the cumulative effect of weather on fire risk, in so far as use of a single factor can be considered adequate to do so.

Seasonal temperature data were tried instead of annual means, and other combinations of months thought to pertain more closely to the fire season, with no apparent gains in the degree of correlation. The inaccuracies of the data, the short time period, and the use of a single factor instead of intricate multiple corre-

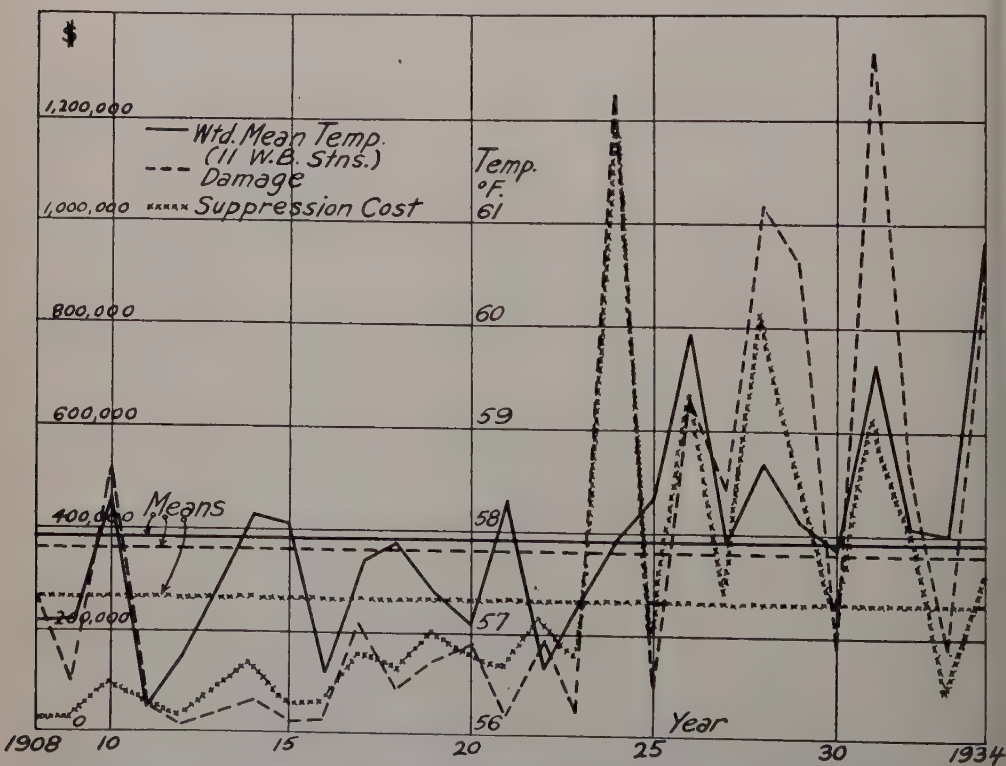

Fig. 2.—Actual and mean values of annual mean air temperatures for selected stations (1908-34), and forest fire suppression costs and damage in California National Forests for the same years.

lations utilizing all pertinent factors, are responsible for lack of closer agreement between the fire and weather data presented.

In conclusion, it may be said that an interesting and useful partial correlation between air temperature and economic fire factors has been demonstrated in terms of cumulative general trends over long time periods. In California, past accumulated excesses of air temperature above average have been accompanied by similar accumulated excesses of suppression costs and fire damage above average, and vice versa.

Trends in a cumulative sense have been rather consistently downward from 1907 to 1923, and upward since 1923. An apparent leveling off since 1933 in temperature and other weather factors indicates a possibility that the peak of accumulation may have been or shortly will be reached, with a succeeding downward trend in the near future similar to that from 1908 to 1923. However, this is conjecture, and not a definite forecast.

THE PRINCIPLES OF MEASURING FOREST FIRE DANGER

By H. T. GISBORNE

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The current adjustment of fire control action to the prevailing status of fire danger is basic to efficient forest fire control. Unless this is done, expenses will be too high in some years and losses will be unnecessarily great in others. It is therefore essential that the prevailing status of fire danger be determined accurately and with as great refinement as is warranted by the flexibility of the fire control organization. The article describes the technique of applying the device known as a fire danger meter to obtain a numerical rating of fire risk.

RESEARCH in fire danger measurement was commenced in 1922 at the Northern Rocky Mountain Forest and Range Experiment Station of the U. S. Forest Service, with headquarters at Missoula, Mont. Since then investigations have been made concerning (1) what to measure, (2) how to measure, and (3) field use of these measurements. In all cases the laboratory or restricted field experiments have been followed by several years of extensive application and test on the 10 fire forests of northern Idaho and western Montana, comprising an area of some 17,000,000 acres.

From this work three basic principles have become evident. They are:

1. All the significant daily variables of fire danger must be measured or dependably estimated.

2. These measurements must thoroughly sample the forest property.

3. The net effect of the several variables must be determined by some method so that, whoever applies it to the measurements for a certain day and area, the same rating of danger will be arrived at.

These principles do not demand that certain factors be measured in all forest types, that a certain number of stations be used per unit of area, or that the use of experienced judgment be eliminated. The research and field tests have shown, however, that unless all the significant factors are considered, unless each fire and climatic type is properly represented, and unless the applications of personal judgment and estimate are standardized, the resultant ratings of fire danger will not be as accurate or refined as they can be made by adherence to these principles.

Factors That Affect Fire Danger

Studies of going fires and the analysis of fire reports have shown for the Northern Rocky Mountain Region that at least five factors affect the fire danger, which varies from day to day and season to season.[1] These variable factors are: (1) date, or season, (2) fuel moisture, or inflammability of specific materials, (3) wind, (4) visibility range, and (5) activity of fire-starting agencies. Some of these factors include two or more sub-factors, but each of the five listed is of major significance in this region.

Date, or Season.—Even though temperature, humidity, wind, and fuel moisture may be the same in mid-June as in mid-July, or even mid-August, the green vegetation such as grass, weeds, and brush is maturing, curing, and becoming less a fire retardent and more a fire accelerator as the season progresses. Hence danger increases with date, up to

[1]Topography and fuel type (3) are factors of fire danger which vary from forest to forest.

a certain point. An allowance is made for this variation in the Northern Rocky Mountain scheme. Even more consistent with calendar date is the number of hours of dangerous burning weather, according to hours of sunshine each day.

On September 15, for example, there are at Missoula, Mont., 3.3 fewer hours of sunshine and 3.3 more hours of cool, calm, humid weather favorable for fire control than there are on June 15. This shortening of the fire day opposes and finally offsets the effect of maturing vegetation. Both the vegetative factor and the hours-of-sunshine factor are, at present, brought into the rating according to calendar date.[2]

Fuel Moisture.—This variable, which determines forest inflammability, is the second most important one considered by the Northern Rocky Mountain method. The top layer of duff and half-inch-diameter dead branchwood are the two fuels measured. The drier these fuels, the greater the danger, and in determining current danger it does not matter whether this dryness is controlled by precipitation alone, humidity alone, or any combination of precipitation, temperature, humidity, wind, and sunshine. Fire research in this region has shown (1) that if surface duff or litter moistures and the moistures of small dead branchwood (2) are measured, the inflammability of a majority of the dead fuels is accounted for. A statistical analysis (4) of the influence of weather factors on the moisture content of these fuels has shown that even very complete weather measurements cannot be used dependably every day for this purpose.

Some of the finer fuels such as tree moss, dead grass, and weeds also contribute appreciably to fire danger when they are extremely dry. As the moisture contents of these fuels change faster than duff or twigs and lag only a few hours behind relative humidity, the Northern Rocky Mountain method provides a higher rating of danger whenever the humidity drops below 15 per cent.

Wind.—Many experienced men believe that wind is one of the most important variables of fire danger. Cases can be cited of crown fires occurring with snow on the ground, and of blow-ups during high humidity. In all such cases a high wind is usually the cause, and when the fuels are dry and the humidity low, even a small increase in wind velocity immediately accelerates the rate of spread of fire. Wind velocity, therefore, cannot be omitted from any complete scheme of rating fire danger. In the Northern Rocky Mountain scheme wind is given almost as much weight as fuel moisture.

Visibility Range.—The distance at which small smokes may be detected is a factor in fire danger. Visibility conditions may be such as to permit seeing small smokes 20 miles or more from a lookout, or the atmosphere may be so hazy that new fires can occur within 1 mile of a lookout, yet not be seen. When visibility is restricted there is greater danger of fires becoming large, more lookout stations must be manned, and in dry weather more men must be sent to every fire that escapes quick detection. In the early spring, before the average season fire control organization is warranted, the only action needed may be the placement of a few observers at their stations, their distribution depending primarily upon atmospheric visibility range.

Fire-Starting Agencies.—Fire danger and fire control are, of course, affected by the activity of any fire-starting agency. Lightning, which causes about 72 per cent of the fires in Region One, is there-

[2]The fact is recognized that vegetation starts growth earlier and stays green and is a fire retardent much later in some years than in others. A research project is being carried on in an attempt to determine more accurate vegetative criteria (5).

fore brought into the Northern Rocky Mountain scheme.

The fire records show that man does not produce peak loads of fires in Region One. Consequently this scheme does not rate danger higher on week-ends and holidays even though there are more people in the forests at such times. An allowance is made, however, for increased danger whenever numerous land-clearing fires, permitted by law, are occurring adjacent to the forest property being protected.

These five factors, date, fuel moisture, wind, visibility, and certain fire-starting agencies, have therefore been selected as the principal variable controls of fire danger in Region One. On any midsummer day only one of these may contribute to fire danger, while the four others subtract from it. Or any two factors may contribute, while three subtract.

In fact, if we distinguish merely between two classes, those favorable to high danger and those favorable to low fire danger, without any regard for the degree of favoritism, 120 combinations of these five factors are possible. Hence it is not surprising that forest managers have in the past failed to agree when, for instance, date and duff or wood moisture have been conducive to high fire danger while humidity, wind, lightning, and visibility were favorable to easy forest protection.

Classes of Fire Danger

With five factors combining their effects or counteracting each other, the integration cannot be left to personal opinion or judgment. This is especially true if large expenditures of funds are to be based on the resultant opinion, or if the daily opinions are to be combined at the end of a fire season into a seasonal rating to be used in determining efficiency of fire control. To rate fire danger some method must be used, such as Koppen's system of classifying climates, so that whoever applies the system will arrive at the same result as another using the same basic data. The more numerous the factors, the more essential such a system becomes.

Each significant degree or class of danger must then be designated in such a manner that all danger reports are consistent and comparable. There is little consistency and less comparability in designations such as "none, easy, average, bad, and very bad" when applied by numerous men of different temperament and varying observational experience.

The Northern Rocky Mountain scheme divides the total range of danger into seven classes. This number was chosen because in this region there are at present seven rather definite stages or steps in fire control organization. These are as follows:

Class 1. No men need be specially detailed to fire control.

Class 2. Fire control stations covering heavy slash or active brush-disposal operations should be manned. A few key lookouts also may be manned following lightning storms early in the season.

Class 3. All key detection stations should be manned and the limited number of guards and smokechasers included in the "minimum protective organization" should be sent to their stations.

Class 4. The "average season protective organization" should be placed.

Class 5. The "first overload" positions should be filled.

Class 6. The "second overload" positions should be filled.

Class 7. Every economically justifiable step should be taken, including the mobilization of supplemental overhead, stationing crews of firefighters at strategic points, and other action specified by the Region One fire-control plan for meeting the most extreme fire danger.

Actually there is no sharp division

between one class of danger and another, and in actual practice the fire control organization is not expanded suddenly from one stage to the next. Perhaps 100 gradations could be set up, but for all practical purposes the present distinction of seven classes of danger and seven stages of organization are as refined as is needed at present.

In addition to the advantage of correlating fire control action with degree of danger, the numerical scale of one to seven serves another very practical purpose. Previous to the adoption of this scale forest managers had no standard terminology whatever for describing fire danger. Usually, the more expletives used, the greater the danger, but when expletives had to be eliminated the reporting officer often had difficulty in specifying extreme and critical conditions. The provision of a definite scale was immediately recognized by field men as an aid in describing the status of fire danger consistently and understandably. It was a material factor in the substitution of fire-danger measurements for fire-danger "guesstimates" on the National Forests in Region One.

Fire Danger Meter Designed

The integration of effects of the five outstanding factors of fire danger so that all of the 120 combinations can be expressed on a scale of 1 to 7 requires the use of some sort of nomograph, alinement chart, or slide rule. A simple device, called the Harvey exposure meter, has long been used for a similar purpose in photography, and this idea was used in designing a fire danger meter, illustrated in Figure 1.

This pocket-size cardboard device is easily adjusted to register the status of each of the six factors of fire danger. The resultant class of danger is then indicated on the scale of 1 to 7. Although this device is complex at first glance, its manipulation is not difficult after a few minutes' practice. It has been readily adopted in Region One.

For best daily and seasonal use a record should be kept to show for each day the status of each factor of fire danger and the resultant class of danger. Figure 2 shows the type of chart used in Region One for this purpose during 1933, 1934, and 1935. The values plotted on this chart are the 1935 daily averages for all the stations used in this region. An improved chart has been designed for use in 1936.

With a record of this kind available for a ranger district, a National Forest, or an entire Region, the forest manager is aware, during the season, of the existing status and the current trend of each element of danger. The meter then shows the fire control organization warranted or justified.

On the 10 fire forests of Region One, the measurements of factors are made in early May at less than a dozen stations. These are at the lower elevations. By early July or after the lookouts have been placed, as many as 180 lookout, smokechaser, and ranger stations measure one or more elements of fire danger. Approximately 70 stations serve as the major network for the 17 million acres included in these 10 Forests. This represents an average of one complete weather and inflammability station per 240,000 acres. During the past three fire seasons this distribution has appeared to be sufficient to reveal nearly all local differences in danger warranting different fire control action.

At the close of each fire season the daily record of fire danger may be used to rate the character of any part of the season, or of the season as a whole. As shown by Figure 2, in July and August, 1935, there were 0 days of Class 1 danger, 2 days of Class 2, 10 days of Class 3, 22 days of Class 4, 27 days of Class 5, 1 day of Class 6, and 0 days of Class 7. Multiplying the number of days by

its class value gives a total of 263, which divided by the total number of days, 62, gives an average danger class of 4.24 for this period.

Other records indicate that the rating for the easiest probable July and August would be about 2.8, while that for the worst probable would be 5.5. Class 2.8, therefore, represents zero danger and 5.5 represents 100 per cent for this period. On this scale, the 1935 average of 4.24 represents 53 per cent of worst probable danger.

This method, therefore, makes it possible to express the character of fire danger on a percentage basis which is readily understood by boards of directors, state legislators, and congressmen who are not familiar with, and perhaps not interested in, the detailed technique of danger measurement. Rating on a percentage scale also permits ready comparisons of successive seasons on a Forest, or comparisons between Forests for a particular season. For example, July and August rated as 46 per cent of worst probable in 1933, 71 per cent in 1934 and 53 per cent in 1935. The individual National Forests could be likewise compared.

In comparing one year with another, we need to consider length of fire sea-

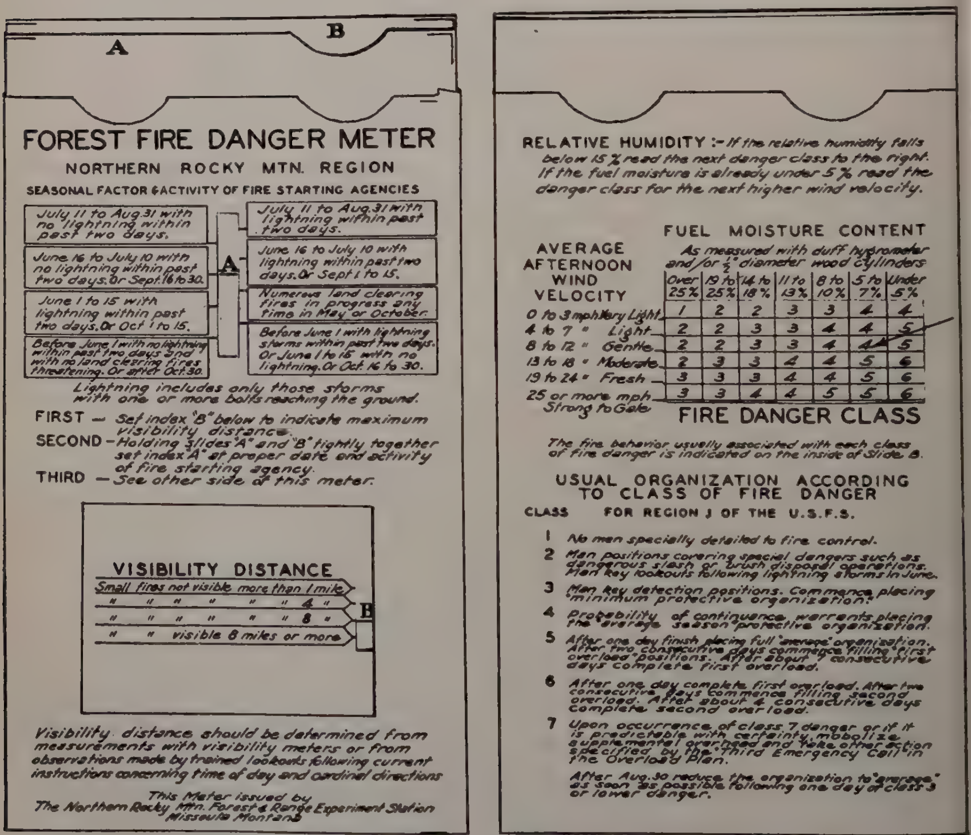

Fig. 1.—The forest fire danger meter.

Left: front view. At the top are two slides, marked A and B. These slides are movable and are read through windows in the outside of the holder.

Right: back view. The dimensions of the folder are 3⅞ inches by 6¾ inches.

son as well as intensity, because a four-month season rating, say, 50 per cent of worst probable may justify greater organization costs than a two-month season rating 65 or 70 per cent. The records for Region One do not, however, as yet include a sufficient variety of seasons to indicate the best method of incorporating the length-of-season factor.

Rating Fire Control Efficiency

As an indication of the use of seasonal ratings to determine efficiency of fire control, Table 1 shows several relationships that are sometimes overlooked.

First is the fact that even during the most favorable fire seasons some minimum, $250,000 assumed in this case, must

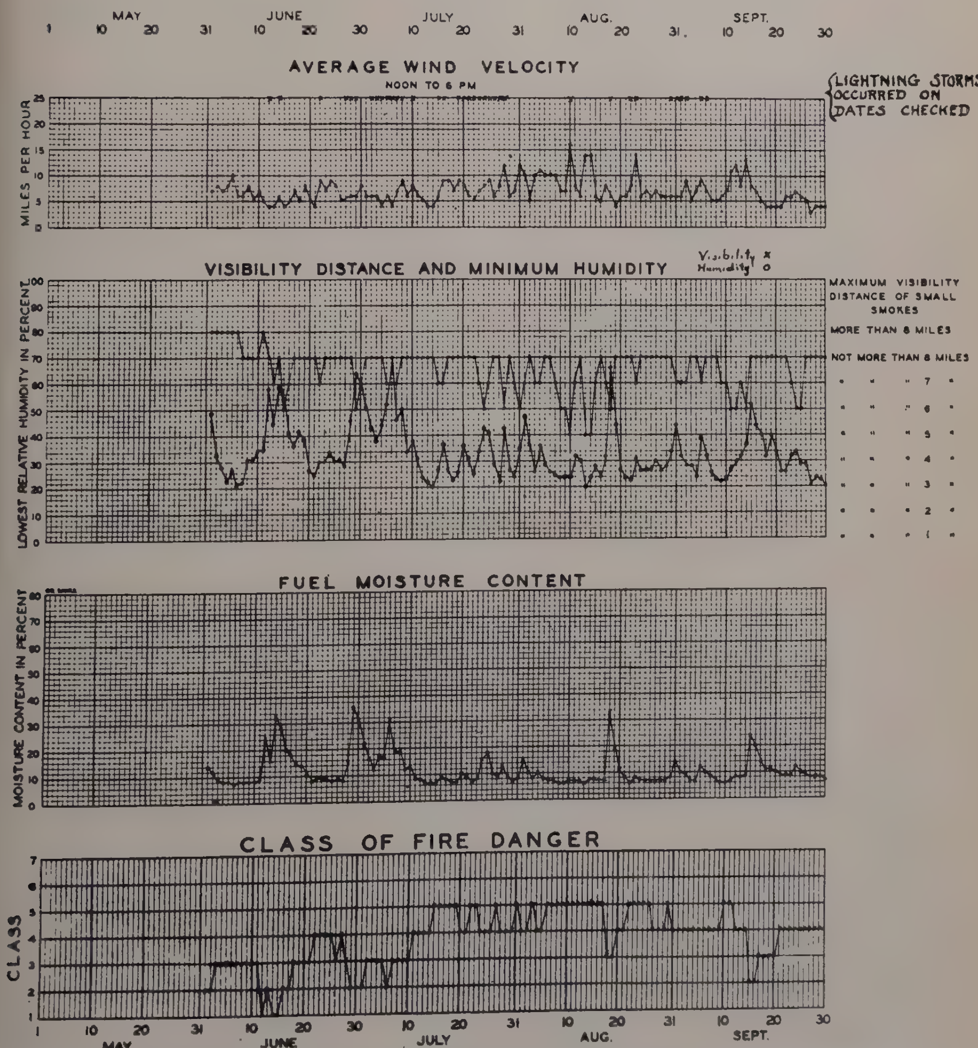

Fig. 2.—Type of chart used to record fire danger in ten National Forests in Region One during 1935.

be expended for the maintenance of fire-control facilities and a skeleton fire-control force of men.

Second, as the character of the fire season becomes more dangerous the control force must be increased proportionately, or the property will be unduly exposed to damage.

Third, the ultimate objective of efficient fire control is to follow the very narrow path between acceptable expenditures and too risky exposure of the property.

Fourth, as danger increases more leeway should be allowed to compensate for those unfavorable catastrophes that so often characterize critical seasons. In Table 1, a 91 to 100 per cent season allows a leeway of $1,000,000 in total costs plus damage, while a 31 to 40 per cent season restricts efficient work to a range of only $250,000. The bare minimum of maintenance costs is acceptable, with no allowance for damage, if the character of season rates as less than 10 per cent of worst probable.

Fifth, such a scheme definitely specifies the maximum total cost plus damage that will be accepted as efficient for each specific class of season.

Without some such system of comparing cost plus loss with character of fire danger, efficiency ratings can be at best only impartial and thoroughly experienced judgments. If the judge has incomplete information concerning the character of season, if he is unfamiliar with fire behavior and fire-control practices in the region in question, if he is a personal friend or a personal enemy of the fire-control manager being judged, or if the judge's health happens to be below par at the time, his rating of efficiency of the work is not likely to be as just and impartial as it would be if the criteria of efficiency were deliberately specified.

By measuring fire danger and by testing the relationship of cost-plus-loss to character of season, it should be possible to produce experience tables similar to Table 1 which will permit the rating of

TABLE 1

EFFICIENCY OF FIRE CONTROL[1]

Total costs plus damage	Character of season — Per cent of worst probable: 10 or less	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	81 to 90	91 to 100
	Efficiency A = Acceptable. E = Excellent									
Dollars										
250,000	A	A	E	E						
315,000		A	A	E	E					
400,000			A	A	E	E			Too risky	
500,000				A	A	E	E			
630,000	Too costly				A	A	E	E		
800,000						A	A	E	E	
1,000,000							A	A	E	E
1,260,000								A	A	E
1,600,000									A	A
2,000,000										A

[1]These relationships might apply on a forest area of 25 to 30 million acres requiring fire control facilities of a type and quantity necessary in a region of fire behavior similar to that in Region One.

fire control efficiency by the same principle that life and fire insurance companies use in judging a human or property risk. These companies could not operate for long if they let each of their many agents judge each risk on the basis of the agent's limited and very personal experience. Such judgment and rating should be a procedure inherent in the business, not a personal ability of the employees.

By the methods described here it is possible to determine the prevailing status of fire danger far more accurately than it can be estimated, and on this basis to adjust the size of the fire control organization so that unjustifiable expenses and unnecessary losses may be reduced. Later it may be possible to rate efficiency of fire control much more precisely than is possible by personal judgment alone.

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AN EYE TEST FOR FIRE LOOKOUTS

By RICHARD E. McARDLE and GEORGE M. BYRAM[1]

U. S. Forest Service

The eye test described here appears to give reasonably reliable indications of the maximum distances at which those taking the test may later see small columns of smoke from forest fires, and for this purpose is thought to be superior to the ordinary tests for visual acuity.

SINCE the primary function of fire lookouts is to look for fires, it is customary to require applicants for this work to demonstrate their "seeing" abilities. Ordinarily this test for quality of vision is given indoors, using the familiar Snellen test chart with its rows of large and small letters. Although the Snellen test is satisfactory for the purpose for which it originally was intended, it does not appear to give reliable results when testing ability to see smoke of small fires at long distances.

While making studies to determine how far lookouts can see the smoke from small fires, the need arose for an eye test which could be correlated with the results of the smoke-distance experiments. This new test is given out of doors, over a distance of several hundred feet, with the observer facing the sun, and thus better approximates conditions prevailing at lookout stations. Moreover, guessing is very nearly eliminated.

Briefly, the procedure with this "lookout eye test" is to determine how far a small white spot on a black background can be seen. Those who must approach closer than 450 feet in order to see this white spot probably do not have sufficiently keen vision to qualify as lookouts.

The equipment needed is (1) a piece of soft wallboard (such as "firtex") 22x36 inches, covered on one side with black percale or other dull black cloth, and (2) a white spot ⅜-inch in diameter. The white spot can be made by boring a ⅜-inch hole in a small piece of sheet metal painted with flat black paint, backing it with white cloth, and bending two edges down over a block of wood about ⅝-inch square by ¼-inch thick. This metal cover can be removed from the wood block for replacement of the white cloth when it becomes soiled. A needle or sharpened brad is fastened to the under side of the wood block (projecting about ¼-inch) so that the spot may be fastened to or removed from the wallboard panel.

To give a test, select a level place, such as a meadow, where an unobstructed view may be had for a distance of about 600 feet north and south. The examiner stands at the south end of the test course and holds the large black panel about shoulder high with the long edge of the panel parallel to the ground. The cloth side faces north. The test must be given while the sun is shining, but the direct rays of the sun must not fall on the cloth side of the board during the test. (The examiner may hold the board in the shade of a tree.) The white spot is placed on the cloth side of the black panel, about 11 inches in from one end and midway between the top and bottom of the panel. The person to be tested

[1]This test was devised while the authors were employed by the Pacific Northwest Forest Experiment Station, Portland, Oreg.

walks north about 300 feet from the examiner, turns, and if he can see the white spot from this distance, walks 15 or 20 feet farther, continuing in this manner until he can barely distinguish the white spot. Here he gives an arm signal for a check test. To give the check test—i.e., to determine if the lookout applicant is at the maximum visibility distance—the examiner reverses the black panel (or has the lookout turn his back to the examiner) and either (1) leaves the white spot where it is, (2) moves it to a similar position at the other end of the panel, or (3) removes the white spot. He then swings the board back to its original position facing the man being tested (or by a whistle signal notifies him to turn around). The lookout applicant then indicates on which end of the board he sees the white spot, or signals its absence. If incorrect, the examiner motions him to step forward about 5 feet. He repeats this check test a few times until he is satisfied that the observer has reached the limit of his vision. The distance from the examiner to the observer (measured to the nearest 5 feet) is referred to the following table to obtain an eyesight rating.

Eyesight Rating Scale

(For use in full sunlight)

Maximum distance at which white spot can be seen Feet	Quality of vision
Less than 300	Poor
305 to 350	Fair
355 to 450	Average
455 to 500	Good
505 to 550	Very good
Over 550	Exceptional

Those taking this test should be cautioned against staring too long at the panel; if the white spot is not seen within a few seconds, it is unlikely that continued searching will make it visible. The examiner will find that many men must be motioned back to greater distances in order to obtain maximum distances. Men should be tested one at a time.

For best results the test should be given between 9 a. m. and 3 p. m. The sun must be shining at the time of the test. (On cloudy days the white spot can be seen not as far or much farther than shown in the rating scale, depending on whether the sky is bright or dark.) It is important that the examiner keep his back to the sun when making the check test, for if the direct rays of the sun fall on the white spot when reversing the board the spot becomes abnormally visible and will be seen by the person being tested. The black panel is large enough not to be appreciably influenced by the character of the natural background behind the examiner, but it is recommended that the examiner select a dark background.

This test has been on trial by the Forest Service in various parts of the United States during the past three years, and apparently meets with the approval of those using it. The test, however, is not to be considered as being in its final form. Additional work is required to check the preliminary indication that the relative distance at which the white spot can be seen forecasts rather accurately the maximum distance at which small smoke columns will later be seen. As data collect, changes may also be required in the rating scale, especially the derivation of a scale for use during cloudy weather.

Should this kind of eye test prove desirable, it is suggested that a standard test outfit be made by gluing black "coverboard" (or black blotting paper could be used) on each side of a 22x22-inch piece of stiff cardboard and sticking a white paper spot (3/8-inch diameter) in the center of one side of this board. The check test would then be made by twirling the board and asking the ob-

server to signal whether the side with the spot or the side without the white spot was turned toward him. Additional gummed spots could be provided for replacement of soiled ones. The whole outfit could be kept in a stout manila envelope on which would be printed the rating scale and directions for use.

No attempt has been made to set up definite standards for acceptance of lookouts. One Forest Service region, however, specifies that only men who rate "good" or better shall be used as primary lookouts.

GOGGLES FOR INCREASING THE EFFICIENCY OF FOREST FIRE LOOKOUTS

By RICHARD E. McARDLE and GEORGE M. BYRAM[1]

U. S. Forest Service

ON the National Forests of Oregon and Washington the peak loads for forest fire lookouts come in the afternoon hours. An analysis of 11,081 fires shows that 55 per cent of these fires started between noon and 6 p. m. Of these fires, 5,891 were discovered by lookouts; and 56 per cent of the fires so discovered were first seen in the afternoon hours. Although there is no experimental evidence to prove that lookouts suffer more from eyestrain in the afternoon than during the morning hours, it is reasonable to assume (and the statements of many lookouts tend to verify this assumption) that several hours of exposure to intense sunlight must produce some detrimental effects on the quality of vision. If this be true, the lookout is least efficient during the afternoon, at the very time he should be most efficient. Moreover, it has been found that about two-thirds of all fires discovered by lookouts are discovered when looking toward the sun. To verify the discovery of these fires the lookout is obliged to face very intense light, which certainly results in additional eyestrain.

Many lookouts customarily wear tinted glasses to reduce eyestrain, and it was felt that an investigation in this field might indicate what kind of colored glasses are best for this purpose. After giving careful consideration to several devices for lowering the general level of light intensity, it seemed that colored glasses offered the most feasible opportunity to accomplish this purpose. Subsequent work therefore was devoted to the best color, the most suitable density, the best shape of lens, and several other characteristics which should be considered in selecting glare-reducing glasses for use by lookouts.

Color

It was not the purpose of these experiments to devise glasses which would "cut through" haze. No filter has yet been found which will absorb the scattered light of short wave length ("haze") without also making smoke columns less visible. Thus, amber or red filters, though ideal for photography because they make visible the landscape behind haze, are of no value whatever for lookouts because bluish fire smoke tends to become invisible when viewed through amber or red glass. The only purpose of the experiments was to find some means of reducing eyestrain by lowering the whole level of light intensity. It was realized at the start that the color of glass selected should not change the natural colors of objects or smoke from fires, since it is more than likely that lookouts will want to put on and take off the glasses frequently and distortion of natural colors to unusual and unexpected shades tends to confuse lookouts.

Much information on the spectral qualities of colored glass is available.[2] Figure 1 shows the transmission proper-

[1]These goggles were developed while the writers were employed by the Pacific Northwest Forest Experiment Station, Portland, Oreg.

[2]Some of the best and most concise sources of information on the light transmission properties of colored glass are in the publications of W. W. Coblentz of the U. S. Bureau of Standards. Especially recommended is his article on "The transmission properties of tinted lenses" appearing in the American Journal of Ophthalmology, 15: 932-941, October, 1932.

ties of glass of various colors.[3] The heavy lines show the amount of light transmitted in various parts of the spectrum. Thus, window glass lets through about an equal amount of each part of the spectrum, approximately 91 per cent of the violet, blue, green, etc. For this reason objects viewed through window glass appear in their natural colors. Blue glass, however, transmits light from the blue end of the spectrum but tends to stop light from the red end, and this gives a blue cast to all objects viewed through this glass, red and yellow objects especially becoming dark when seen through blue glass. Amber glass absorbs light from the blue end of the spectrum but lets through light from the red end. A blue sky appears almost white, and blue fire smoke may be so greatly lightened as virtually to disappear when viewed through deep amber glass. Smoked glass transmits light from various parts of the spectrum in nearly equal amounts, behaving very much like window glass in this respect, and hence does not appreciably change the natural colors of objects viewed through it. A neutral shade, such as smoked, therefore, is the best color for

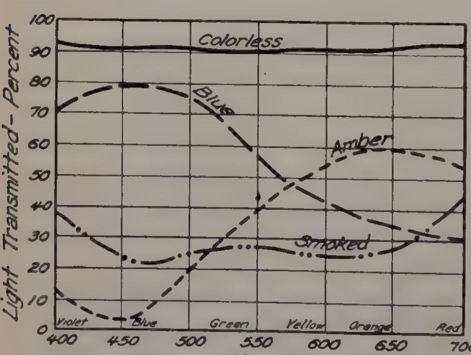

Fig. 1.—Light transmission qualities of sun glasses of different colors.

use by lookouts because it reduces the amount of light reaching the eye, but does not greatly change the natural colors in the landscape.

Before deciding definitely on any one color, field tests were made from several lookout stations and small columns of smoke were viewed through many glasses in addition to the four shown in Figure 1. These tests confirmed the results obtained in the laboratory and showed that smoked glass was the best color to use. It seemed to the investigators that smoked glass had a slight tendency to absorb haze, but no noticeable decrease in visibility of small smoke columns was observed.

Density

The best density of smoked glasses for lookout use was determined by actual field tests from lookout stations and by lookouts who experimented with smoked glasses of different densities. It was desired to recommend a glass dense enough to really protect the eyes and yet not so dense as to decrease visibility of smoke columns from fires or be uncomfortable to the lookout. Individuals vary greatly in their ability to withstand glare. A glass which transmits 30 per cent of the visible radiation will seem to be too dark to some people, and much too light to others. Moreover, glasses for use inside a lookout house can be less dense than those used on open towers. Awnings on lookout houses still further decrease the intensity of light reaching the interior of the houses, and if lookout houses are equipped with shutter awnings, lookouts can use a glass less dense than otherwise would be required. In a semi-desert region, where surrounding objects are so light colored as to reflect strongly

[3]The curves shown in Figure 1 are based on data obtained by the authors in the physic laboratories at Reed College, Portland, Ore. The amber and blue glasses were selected as typica from a large group of sun glasses furnished by the local wholesale dealer in optical supplies The smoked glass is a special density made for this study by the American Optical Company.

and there is much bright sunshine, the lookout needs darker glasses than would be desirable in a heavily timbered locality where less sunlight is reflected. And, among other things, the interior painting of lookout houses (whether light or dark) plays a large part in determining the best density for use in the lookout's glasses.

The glass finally selected transmits about 26 per cent of the visible radiation (see Fig. 1-D). This glass appears to be fairly well adapted to the great majority of lookouts in Washington and Oregon when used inside lookout houses equipped with shutter awnings. For lookouts occupying open towers, or exposed to intense sunlight, glasses transmitting from 15 to 20 per cent of the visible radiation are needed.[4]

The question has been asked whether or not a person wearing dark glasses of the kind described would injure his eyes by suddenly removing his glasses in bright sunlight. Eye specialists have assured the writers that there would be no more danger of this than might occur from moving from a dark room into bright sunlight. A person who had been wearing the glasses probably would feel somewhat blinded for a few moments, but his eyesight would not be injured as a result of wearing dark glasses.

Shape of Lens

After considerable experimentation and consultation with many lookouts, it was decided that the best shape for these lookout glasses is the so-called "sport" type, the lenses of which are pear-shaped. Large round lenses would also be satisfactory in many instances. Round lenses, however, admit considerable light from the side and increase glare by reflection of side light when the lookout has his back to the sun. Pear-shaped lenses of the type selected are hinged at the nose piece, and by fitting closely to the head prevent side glare. Large lenses also are desirable because they eliminate the necessity for purchasing several sizes of goggles to fit different individuals. The pear-shaped type of goggle has the disadvantage of being somewhat hot to wear, as air circulation is impeded.

The frames of the goggles should be of noncorroding metal or other material. The bows must be easily adjustable without the use of tools to fit different individuals. The nose piece should be broad enough to lighten the pressure of the goggles on the wearer's nose, and preferably should be fitted with a removable felt or rubber pad. A metal carrying case is a necessity.

Optical Quality of Lenses

Optically correct lenses are absolutely essential. It is a mystery why apparently well-informed people who would not think of purchasing ordinary reading glasses from the corner drug store or the "five and ten" seem to have no hesitation whatever in buying sun glasses without knowing anything of the type of lens they are getting. Perhaps this is because they do not realize that the lenses of sun glasses are actually lenses, although pressed instead of ground to concave form. Among the hundreds of "cheap" sun glasses examined by the writers were several that had one lens adapted to far-sighted persons and the other lens of the near-sighted type. All of these pressed glasses twist the eye muscles slightly and oblige the eye to assume abnormal positions. Eye fatigue naturally results, and the very purpose for which sun glasses are worn is thus defeated. Figure 2, traced from actual photographs made

[4]For protection from the very intense glare encountered in automobile driving, glasses transmitting only 10 to 15 per cent of the visible radiation should be worn.

through the "corner drug store" type of sun glass, illustrates (distortion magnified) the distortion caused by inexpensive sun glasses.[5]

Harmful Rays

There appears to be considerable advertising activity on the part of various optical goods manufacturers concerning so-called harmful light rays. One company, for example, emphasizes that its special sun glass transmits all radiation and implies that sun glasses of rival concerns which do not transmit ultra-violet light are likely to be "habit forming." Other concerns retaliate by urging the public to protect its eyes from "injurious ultra-violet light." Opthalmologists have not yet determined that it is advisable to exclude from the eye the ultra-violet in sunlight, and the majority seem to feel quite definitely that there is no reason to believe it should be excluded. Most reflecting surfaces, except snow and water, according to Coblentz,[6] absorb a much greater amount of the ultra-violet than the visible rays, and if sunlight is the only light source protective measures should be concerned mainly with the glare produced by visible light and not with the presence of ultra-violet radiation. (If there is an exceptional amount of ultra-violet radiation, as in arc welding, which shines directly into the eye, special protection against ultra-violet radiation is needed.)

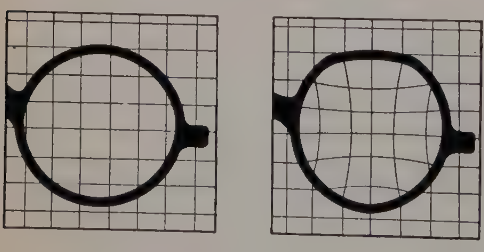

Fig. 2.—A, crown glass optically finished to eliminate distortion; B, pressed glass. (From photographs.)

As a matter of fact, ordinary colorless eye glasses shut out ultra-violet radiation below about 320 millimicrons and transmit only a very narrow band of ultra-violet rays. Use of a special glass to stop transmission of the relatively insignificant amount of ultra-violet radiation not kept out by ordinary glass probably is not necessary. Since ordinary blue print paper is "printed" chiefly by ultra-violet radiation, a very simple test can be made to prove or disprove that any particular glass stops the ultra-violet rays. Simply place a penny, a piece of ordinary window glass, and the supposedly ultra-violet-proof glass on a small piece of blue print paper, and after exposing for a few seconds to intense sunlight wash in the usual manner. The paper under the penny will be white, because no ultra-violet rays reached that spot; the paper underneath the window glass will be blue, because it transmits a narrow band of ultra-violet immediately below the violet; and the paper underneath the other glass will be white or blue depending on whether or not it transmits a narrow band of ultra-violet radiation like the window glass or stops it as does the penny. Smoked glass treated in this way results in a partially printed spot on the paper, indicating that this glass does not transmit quite as much ultra-violet radiation as ordinary window glass.

The possibility that infra-red radiation might be injurious to the eyes was not

[5]If the uncorrected type of sun glasses must be purchased, select flat lenses, or if these are not available the "sport" type with pear-shaped, thin-glass lenses. In these types there generally is less distortion and it is easier for the purchaser to detect distortion than in sun glasses having concave lenses of very thick glass.

[6]Coblentz, W. W. Glasses for protecting the eye from glare. Jour. Amer. Med. Assoc. 95: 593-594. 1930.

investigated. These are the heat waves, and there is no particular reason to believe that the eyes should be protected from them under the conditions encountered by fire lookouts.

Bid Specifications

Goggles Glare Reducing.—To be made of crown glass, optically finished to eliminate all distortion. Glass to be of neutral tint, giving approximately constant absorption for all visible radiation. (There must not be a deep selective absorption band within the visible range of the spectrum.) "Smoked" glass such as is used in the "Autoglas" manufactured by the American Optical Company will meet these specifications for neutral tint. The transmission of visible radiation to be from 20 to 30 per cent; the two lenses in one pair of goggles must transmit approximately the same amount of light, not varying in this respect more than 4 per cent. The lenses and frames to be of the pear-shaped ("sport") type, approximately 2⅛ inches in greatest width and 2⅝ inches in greatest length. The frames are to be of noncorroding metal; quotations must specify material used. The bows are to be flexible and easily adjustable without tools to individuals requirements. Goggles must be hinged at the bridge to permit adjustment to individual requirements for fitting. A broad, comfortable nose rest shall be provided. Each pair of goggles to be provided with a metal case to reduce possibility of breakage. Bidder to submit sample goggles with quotation.

Results

More than 500 pairs of these glasses were purchased from the American Optical Company and have been used by fire lookouts in the National Forests of Oregon and Washington since the summer of 1933. The goggles cost $2.17 each in lots of one hundred; the retail price is $3.50 per pair. Experience with the goggles to date seems to be uniformly satisfactory, only about 1 per cent of the lookouts objecting to their use. Practically all of the lookouts have welcomed them, and report that the shape, color, and density are wholly satisfactory and that the goggles are a worthwhile piece of equipment for fire lookouts. Many lookouts also claim that small columns of smoke can be seen at greater distances when wearing the goggles than with the unaided eye. It is fully realized that eyeglasses are extremely personal equipment, and their use and value is subject to considerable difference of opinion on the part of different individuals. It is doubtful if it would be wise to insist on their use by lookouts who do not care to wear sun glasses, but men who do want them should be equipped with first-quality glasses. Since these men are stationed on lookout points to obtain information through use of their eyes, they should have all possible aid and protection for their eyes. They should not be permitted to use inferior sun glasses.

In conclusion, if lookouts cannot be provided with first-quality sun glasses, they will find that wearing a sun visor will materially reduce eyestrain. Such a visor (or hat with a broad brim) also is necessary when wearing sun glasses out of doors, for if the glasses are dusty and direct sunlight falls on them vision will be impeded rather than helped.

SOME VISIBILITY FACTORS CONTROLLING THE EFFICIENT LOCATION AND OPERATION OF FOREST FIRE LOOKOUT STATIONS

By RICHARD E. McARDLE

U. S. Forest Service[1]

IT IS now well established that forest fires must be discovered in the incipient stage if fire suppression costs and first losses are to be kept at a minimum. For many areas the lookout system is cheaper and more effective than other methods of fire detection. Extensive lookout systems such as are required on most National Forests necessitate large expenditures for lookout houses, towers, roads, trails, telephone lines, salaries, and maintenance, and returns commensurate with these investments can be obtained only if the lookout stations are properly placed.

The proper placement of lookout stations requires that they should be located so that lookouts have direct views of areas where fires are most likely to occur. This can be accomplished by a study of statistics on fire occurrence and the preparation of "seen area" maps showing the areas directly visible from various observation points. Different combinations of these maps are made until a combination of observation points is found which gives maximum "coverage" at least expense for detection. This planning work cannot be completed, however, without definite information on the maximum distance at which the smoke of small fires is visible. For although a lookout is placed so as to have a direct view of areas where fires are likely to start, he still may fail to discover fires in the incipient stage simply because he is too far from the areas to see smoke columns when fires are small and more easily and cheaply controlled. If, however, stations are very closely spaced, detection costs become unreasonably large. Hence information on visibility factors and the maximum "safe" range of visibility plays an important part in effecting a balance between economy of fire detection and economy of control.

Although these studies were made primarily for use in Washington and Oregon, they are fundamental in character and the principles established should be applicable in other forest regions.

Some Fundamental Aspects of Distance of Visibility of Smoke Columns

There are many physiological and psychological factors, such as experience, attention to business, interest, fatigue, and visual acuity, that affect the quality of a lookout's performance in detecting fires. These factors are personal, intimately related to the peculiarities of lookouts as individuals, and vary considerably between different men.

There also are physical factors external to the lookout that influence the distance of visibility of small columns of smoke. Some of these are:

Atmospheric conditions, particularly haze brightness and lack of transparency of the air.

[1]Formerly in charge of forest fire research at the Pacific Northwest Forest Experiment Station, Portland, Oreg., where these studies were made. The author acknowledges the assistance received from a large number of Forest Service employees, particular mention being due George M. Byram.

Intrinsic brightness of backgrounds.

Position of the sun with respect to smoke columns as viewed by lookout.

Size of smoke columns.

Cloudiness of the sky.

Shadows in valleys and canyons when the sun is low.

The maximum distance at which small smoke columns can be seen is, therefore, controlled by a number of factors. The important physical factors external to the lookout are (for any one size of smoke column in sunlight): atmospheric conditions, backgrounds, and position of the sun. These three factors are so closely related and their influences so intimately interwoven that they must be discussed more or less simultaneously.

Particles of water or of solids such as dust and smoke in the air decrease its transparency or clearness, and create a condition commonly referred to as "haze". There is always some "haze" in the air, and even on the clearest days each mile of the lower atmosphere absorbs and scatters 3 or 4 per cent of the light traveling through it. That the amount or density of haze has a marked influence on the distance at which smoke columns can be seen is recognized by everyone who has compared visibility of distant objects on clear days with visibility on days when the air has a large amount of smoke or dust particles. The actual density of the haze varies through a rather wide range, but even small changes in density of the haze produce surprisingly large changes in the distance at which small smoke columns can be seen. Small or even moderate changes in haze density are very difficult to detect without instrumental aid, and generally go unnoticed by lookouts.

The more nearly the observer faces the sun, the more light is reflected to the observer and the brighter the haze becomes. Haze brightness almost invariably is confused by lookouts with haze density; it is commonly assumed that bright haze means dense haze and therefore decreased visibility. For this reason, lookouts usually estimate more haze and consequently shorter visibility distances toward the sun than away from the sun.

The brightness of the smoke column likewise changes as the position of the sun changes. Figure 1 illustrates the results of a laboratory experiment made in 1932, in the early stages of this study, to determine how the brightness of a smoke column varies according to size of the angle between sun, smoke column, and observer. It will be noticed that much more light is reflected to the observer (and the smoke column therefore appears to be brighter) when this angle is small—that is, when the observer must face the sun to see the smoke column. This effect can be observed out-of-doors in early morning or late afternoon on any day when the sun is shining and smoke columns are visible toward and away from the sun.

Contrary to popular opinion, the maximum distance at which small columns of smoke can be seen is influenced more by the contrast in brightness between the smoke and its background than by the color contrast. Except for short distances in unusually clear weather, the background is composed of haze which has about the same color as the smoke column itself. The color of the background is important chiefly for its effect on relative brightness of the background. For example, a field of yellow-green grass is 8 times brighter than the dark green foliage of a mature Douglas fir forest; barkless, sunbleached snags are 7 times, bracken fern 3 to 4 times, lodgepole pine 2 times, and ponderosa pine 1½ times brighter than Douglas fir. The amount of contrast between a distant small column of smoke and its background depends on the brightness of the background, the brightness of the smoke column itself, and the brightness of the haze between the observer and the smoke

column. Lack of space prohibits giving a more detailed account of how these several factors interact to increase or decrease the distance at which a small column of smoke can be seen, but a complete account has been prepared and may be consulted elsewhere.[2]

The Safe Limit of Visibility for Small Smoke Columns in Sunlight

The term "visibility distance" was coined to express concisely the maximum distance at which lookouts can safely be depended on to discover smoke from small fires.

Visibility distances were determined by sending up smoke columns (of approximately constant size) at progressively greater distances from a lookout point until an observer stationed on that point could just barely see the smoke column.[3] When this distance of maximum visibility was reached, the observer made instrumental measurements of the various physical factors previously described.[4] During the course of the study a dozen or more regularly established

[2]Byram, George M. Physical factors affecting the visibility of small smoke columns. Manuscript Report, Pacific Northwest Forest Experiment Station, Portland, Oreg., August 1, 1935.

[3]The smoke columns were produced by specially constructed smoke pots. These smoke pots burned for about 5 minutes and produced smoke columns of nearly constant and equal volume and closely approximating in color the smoke of actual fires. The officials in charge of fire detection planning had stipulated that information on visibility distances was wanted for a fire which could barely be seen under optimum conditions at a distance of 15 miles. The size of the smoke column was adjusted (by changing the size of the smoke pot) until this requirement was met. A single smoke column was approximately equal to that produced by a fire covering about 10 by 20 feet in Douglas fir or ponderosa pine duff on a dry midsummer day. Actually, this size of smoke column can be seen (in very clear weather) at 16½ miles by lookouts having exceptional eyesight; it was necessary, however, to plan the studies for persons having the poorest quality of eyesight likely to be acceptable for lookout duty. For these men, 15 miles is about the limit of visibility under the best conditions for the size of smoke column used in this study.

Fire control executives will be interested in knowing how this size of fire compares with the size of fire ordinarily picked up by lookouts. Size of fire on discovery as shown on the fire reports admittedly is a guess if the fires are discovered by lookouts, but it is evident from the records that attempts are made to harmonize the estimates made by lookouts with what the fireman actually finds when he reaches the fire. For whatever they may be worth, the table below gives the results of an analysis of 3,000 fires discovered by National Forest lookouts in Washington and Oregon during the 5-year period 1928-32.

Size of fire when discovered	Per cent of total number of fires
Less than 50 sq. ft.	24
51 to 500 sq. ft.	14
501 to 5,000 sq. ft.	21
⅛ to 3/16 acre	12
¼ to ⅜ acre	10
½ to ⅝ acre	5
¾ to 1 acre	6
Larger than 1 acre	8
	100

[4]Byram, George M. Visibility photometers for measuring atmospheric transparency. Jour. Optical Soc. Amer., 25:388-392, December, 1935. The "haze meter" also described in this article was developed at a later date for use by lookouts, is not the instrument used in this experimental work, and is not suitable for such work without using certain correction factors. (The haze meter is based on maximum visibility distance when the background is 60 per cent as bright as the horizon in the same direction; actually this figure varies from about 50 to about 90 per cent, depending on the distance of the smoke from the observer. Moreover, as a safety factor, the haze meter has been designed so as to show maximum visibility distances 30 per cent less than true maxima.)

lookout stations or similar observation points were occupied and tests were made under a wide variety of physical conditions characteristic of Washington and Oregon.

It would require a very large number of empirical tests to obtain reliable curves on visibility limits for all the important combinations of the constantly changing, closely correlated physical factors that influence visibility distance. This investigation originally attempted such empirical observations, but in the line of attack reported here all previous concepts were abandoned and efforts concentrated on learning the fundamental principles controlling the visibility limits. These principles were found and their relationships with each other investigated. Knowing these basic principles, it is a simple matter to determine the safe limits of visibility for almost any given combination of the physical factors controlling visibility.

For use in fire detection planning, detailed tables of visibility distance were prepared for many special combinations of these factors. For general use where considerable detail is not required, Table

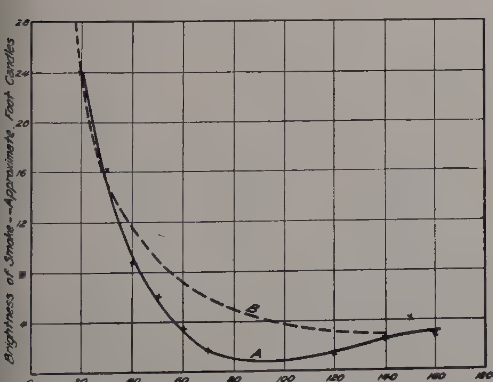

Fig. 1.—(A) Brightness of a small smoke column as influenced by size of angle between observer and the source of illumination. (Data obtained with photronic cell in laboratory experiments.) (B) Brightness of horizon reduced to same units as curve A. (Data obtained photometrically under actual field conditions.)

1 and Figures 2 and 3 give a sufficiently accurate picture of visibility distances for a definite size of smoke column in sunlight as influenced by the three most important physical factors. Table 1 shows only the two maximum "radii" of the closed visibility curves, because it was found that these curves are nearly circular and for all practical purposes may be assumed to be circular. To reconstruct the curves from the data given in Table 1, simply describe a circle having a radius equal to one-half the sum of the two maximum radii, then place the observation point to agree with the two maximum radii.

The interlocking character of three important visibility factors is illustrated by Figures 2 and 3. Even a casual glance at these figures will show that atmospheric conditions, backgrounds, and sun position all work in unison to produce striking variations in visibility distance, which should be taken into account in fire detection planning and in the operation of lookout stations after establishment.

In Figure 2, representing very clear atmospheric conditions, the atmospheric factor is held constant to simplify illustration of the influence of the other two factors. Comparing the two pairs of circles, it can be seen, first, that irrespective of sun position the largest circles are for the darker backgrounds (see also Table 1); indicating that smoke columns can be seen farther against dark than against light (i. e., brighter) backgrounds. Second, it will be noticed that sun position has a very pronounced effect on visibility distance if the smoke columns appear against light backgrounds (the circles are "off center") but has little effect on visibility distance if the smoke appears before a dark background. Against dark backgrounds, smoke columns can be seen about as far when looking away from the sun as when the observer must face the sun to see the

smoke columns. But against light backgrounds the smoke columns can be seen as much as 5 miles farther when they appear toward the sun than when the observer has the sun at his back. This is a direct result of the brightness contrast to which reference already has been made.

Likewise in Figure 3, which represents a hazy day, the same two results again are apparent. Moreover, comparison of Figure 3 with Figure 2 shows the influence of atmospheric conditions on visibility distance when sun position and backgrounds are held constant. That is, the more dense the haze is, the shorter the distance at which smoke columns can be seen (the circles of Fig. 3 are smaller than those of Fig. 2). Figure 3 does not represent the worst possible atmospheric conditions; on the contrary, it shows a condition which apparently occurs in Washington and Oregon at rather frequent intervals during every fire season.

Mention has been made that although the curves of safe limit of visibility are approximately circular, the centers are displaced so that the longer radii are toward the sun. This is not a coincidence. Small columns of smoke actually can be seen farther when the observer faces the sun than when he has the sun at his back.[5] This finding is contrary to popular opinion, but is fully substantiated by theoretical analysis of the fundamental principles involved, by laboratory tests, by a large amount of experimental work with smoke columns in the field, and by comprehensive analysis of fire records.

It was thought, however, that even though small smoke columns can be seen when facing the sun, it still was probable that, because of the intense and disagreeable glare which must be faced, lookouts probably do not discover many fires in the sector toward the sun. Thus the end result would be the same, and seen area maps obviously should be made with the shorter radii toward the sun. To obtain more definite information on this point, the records of 2,647 fires each less than one-half acre in size on discovery by lookouts were studied to determine the proportionate number of fires discovered

TABLE 1.

APPROXIMATE VISIBILITY DISTANCES FOR A STANDARD SIZE OF SMOKE COLUMN (IN FULL SUNLIGHT) DURING THE PERIOD MAY 21 TO SEPTEMBER 30 IN LATITUDES FROM 41 TO 49 DEGREES NORTH

Type of background	Very clear day		Moderately clear day		Hazy day		Very hazy day	
	Noon	8 a. m. or 4 p. m.	Noon	8 a. m. or 4 p. m.	Noon	8 a. m. or 4 p. m.	Noon	8 a. m. or 4 p. m.
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Dark								
(Ponderosa pine and	*14½*[1]	*15*	*11*	*11½*	*8*	*8*	*5*	*5*
Douglas fir forests)	14	14	10½	10½	7½	7½	5	5
Light								
(Vine maple, green bracken fern, and light-	*14*	*14½*	*10½*	*11*	*7½*	*8*	*5*	*5*
colored brush)	12	11½	9	9	6½	6½	4½	4
Lightest								
(Snag areas and dry	*13*	*14*	*10*	*11*	*7*	*7½*	*4½*	*5*
grass lands)	9½	9	7½	7	5½	5½	3½	3½

[1]Each pair of figures represents the visibility distance toward the sun (in italics) and away from the sun (in roman figures). The solar azimuth used in plotting the afternoon and morning visibility distances in Figures 2 and 3 is 76 degrees from the south.

[5]The writer first observed this in the summer of 1932, but does not know whether or not that is the first time this fact has been recognized.

in various sectors toward and away from the sun. It was found (Table 2) that 63 per cent of the fires discovered by lookouts were in a 180-degree sector facing the sun, and 37 per cent in a corresponding opposite sector of 180 degrees away from the sun. (Irrespective of time of day, 23 per cent of all fires were discovered within 30 degrees of a direct line to the sun.) It also was found in these analyses that the average distance of fire discovery was 9.4 miles when the lookout faced the sun and 8.5 miles, or 1 mile less, when he had the sun at his back. The average (estimated) size of fire on discovery was 3,746 square feet toward the sun, and about the same, 3,738 square feet away from the sun. This experience record bears out the statement that more fires are discovered when lookouts face the sun than when they have the sun at their backs.

Table 3, based on another study of 2,865 fires discovered by over 400 lookouts, shows that 64 per cent of all fires discovered between 4 a. m. and noon lie to the east of the lookout. Conversely, during the afternoon hours, from noon to 8 p. m., 66 per cent of all fires were discovered west of the lookouts. For any one lookout this relationship may not hold, because most lookouts are placed to view certain areas where fires are prevalent and a majority of the fires necessarily must be in one general direction from the lookout. But as this tabulation is based on the experience record of more than 400 different lookouts, any characteristics peculiar to individual lookouts are ironed out. For a composite lookout of this kind, fires should occur more or less uniformly all around the lookout if sun position exerts no influence on fire discovery. Since, as shown by Table 3, two-thirds of all fires discovered by lookouts during the morning hours consistently lie east of the lookouts and during the afternoon west of the lookouts, it is evident that sun position does affect fire discovery.

The experience record thus shows conclusively that although it may be more disagreeable to search for fires when facing the sun, lookouts do discover almost twice as many fires when looking toward the sun. The very much larger proportion of fires discovered toward the sun perhaps could be attributed to greater care on the part of the lookouts in searching for fires when facing the disagreeable glare in that direction, but the more logical conclusion is that smoke columns are more visible toward

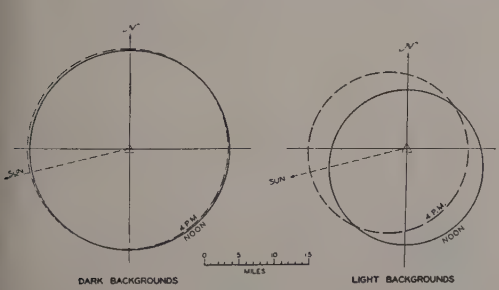

Fig. 2.—Maximum visibility distance of small smoke columns on very clear days. (See Table 1.) For lookouts with good eyesight. Sun position at 4 p.m. is indicated. Corresponding curve and sun position for 8 a.m. would be the mirror image of curve for 4 p.m. In field tests on which these curves are based, smoke columns were in full sunlight; period covered by these particular curves is May 21 to September 30 in latitudes 41 to 49 degrees north.

TABLE 2

INFLUENCE OF SUN POSITION ON FIRE DETECTION BY LOOKOUTS

Horizontal angle between fire, lookout, and sun[1]	Fires discovered	
Degrees	*Number*	*Per cent*
0—30	599	23
30—60	573	22
60—90	504	19
		— 63
90—120	364	14
120—150	301	11
150—180	306	11
	——	— 37
	2,647	——
		100

[1]Effect of vertical angle, or sun's altitude, also was investigated. More fires apparently are discovered at longer distances when looking toward a low sun than toward a high sun.

the sun. If lookouts will use smoked glasses to alleviate the discomfort of looking toward the sun, it is likely that the proportion of fires discovered in the sun sector will increase.

These facts can be put to very practical use. For fire detection work, both in planning lookout systems and later in obtaining maximum efficiency of operation, maps are prepared showing the areas directly visible from individual observation points. For the National Forests in Washington and Oregon these "seen area" maps are circular, with the observation point located at the exact center of the circle. The primary lookout system is based on a 15-mile radius of visibility, and another system based on an 8-mile radius of visibility also is planned for to fill in between the more widely spaced lookouts when visibility conditions are poor and fires cannot be discovered in the incipient stage from more distant points. Figure 2 represents visibility conditions to correspond with the 15-mile maps, and Figure 3 similarly shows how the two most important visibility factors operate to change the safe limit of visibility to a maximum of 8 miles. The seen area maps show only the land surface directly visible from lookout points. Visibility distance maps such as Figures 2 and 3 show the maximum distance at which the seen area maps are truly reliable under given conditions. Hence the two kinds of maps must be used simultaneously, superimposing one on the other.

The seen area maps may be used without modification if the backgrounds are timbered, that is, are dark, for the visibility distance charts show no reduction in visibility distance for dark backgrounds and indicate no change from the true-centered circle likely to result from sun position. When, however, the background in any given direction from the lookout is lighter than a timber background, some allowance must be made in applying the seen area maps if the lookout is expected to discover the small size of fire previously described. The size of this allowance will depend on the kind of background and on the position of the sun as illustrated in Figures 2 and 3.

The forest officer charged with fire detection planning and subsequent operation of the lookout system must decide for himself, with the aid of the experience record for each forest, when fires are likely to "smoke up" in the territory most needed to be covered by any given lookout. On this decision rests the application of the visibility information presented in Figures 2 and 3. If, for example, it is decided that in a certain area where fires are most prevalent

TABLE 3

DIRECTION OF FIRES FROM LOOKOUTS COMPARED WITH TIME OF DAY WHEN DISCOVERED

Time of day when discovered	East of lookouts (azimuth to fire 0-180° from north)		West of lookouts (azimuth to fire 180-360° from north)		Basis: Number of fires	
	Per cent		*Per cent*		*No.*	*Per cent*
4—6 a.m.	62		38		83	100
6—8 a.m.	74		26		194	100
8—10 a.m.	68		32		267	100
10—noon	55		45		335	100
	—	64	—	36		
Noon—2 p.m.	36		64		571	100
2—4 p.m.	35		65		656	100
4—6 p.m.	29		71		500	100
6—8 p.m.	38		62		259	100
	—	34	—	66	——	
					2,865	

they are likely to show up in late afternoon, the forest officer has two choices: (1) reduce the effective distance of the seen area map if the lookout chosen to detect these fires must look away from the sun to see the smoke columns, or (2) use approximately the full distance shown in the seen area map if the lookout must face the sun to detect the fires. Both of these considerations will be more or less modified according to the type of background against which the lookout will view the smoke columns. If the background is dark green timber, the full distance of the seen area map can safely be used in any direction, independent of sun position. If the background is very light, such as is characteristic of snag areas and grasslands, the lookout must be located within 14 miles of the critical area if he has the sun at his back when fires begin to smoke up. (See Table 1 and Fig. 2.) This is for clear weather. The "hazy day" figures in Table 1 and Figure 3 show corresponding reductions which must be applied to the seen area maps when planning the secondary lookout system based on a maximum visibility distance of 8 miles.

Visibility Distances When the Smoke Column is in Shadow

The experimental work thus far described is based on tests made with the smoke columns in full sunlight. In early morning and late afternoon, however, the shadows cast by steep ridges may entirely shade some smoke columns. Full experimental proof of the maximum safe visibility distance of smoke columns in shadow was not obtained. The theoretical visibility distance (partially checked by results of a few field tests) of smoke columns in shadow on a clear day is shown in Figure 4(C). From the small amount of evidence available, it appears that when smoke columns are in shadow there is no appreciable difference in visibility distance caused by type of background; the curve in Figure 4 is for the lightest backgrounds, such as grass and snags, but a similar curve for dark backgrounds, such as Douglas fir timber, would not be much different. Smoke columns in shadow can be seen farther away from the sun than toward the sun. The visibility distance toward the sun is, for all practical purposes, zero. If the degree of slope characteristic of hillsides in a lookout's territory is known, a table of solar altitudes will indicate at which

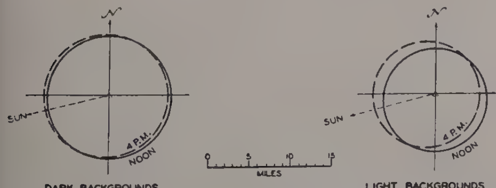

Fig. 3.—Maximum visibility distance of small smoke columns on hazy days. (See Table 1.) For lookouts with good eyesight. Sun position at 4 p.m. is indicated. Corresponding curve and sun position for 8 a.m. would be the mirror image of curve for 4 p.m. In field tests on which these curves are based, smoke columns were in full sunlight; period covered by these particular curves is May 21 to September 30 in latitudes 41 to 49 degrees north.

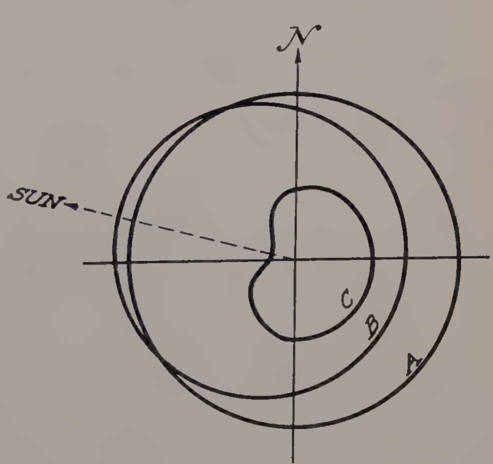

Fig. 4.—Maximum visibility distance of small smoke columns on very clear days (see Table 1) with (A) sky overcast by clouds, (B) sky cloudless and smoke column in full sunlight, and (C) sky cloudless but smoke column in shadow. Backgrounds for all three curves are light, being dry grass or snags. Figure is for 6:00 p.m., June 21, altitude of sun 16 degrees.

hours (and during which months) the altitude of the sun will be less than the slope of the hillsides and hence deep shadows will be cast.[6] Such basic information should be obtained before assuming that shadows will be a significant factor in fire detection planning.

Visibility Distances on Cloudy Days

There are days when the sky is overcast by clouds and the sunlight is more or less equally diffused. When this condition occurs, the contrast between smoke columns and backgrounds is intensified. (The contrast between natural objects such as trees and their backgrounds is, however, decreased.) This "indirect" lighting gives, for all directions from the lookout, somewhat the effect of looking toward a low sun in so far as visibility distance is concerned.

Insufficient tests were made to give reliable information on visibility distances under these conditions. It does appear rather certain, however, that visibility distances are greatest on days when the sky is overcast with light clouds and there is no direct sunlight. The visibility distances away from the sun, moreover, are about equal to the visibility distances toward the sun. This means that the visibility curves will be almost or entirely circular, with the point of observation located at the true center of the circles. Figure 4(A), based largely on theoretical considerations, shows the probable effect of an overcast sky on visibility distances against very light backgrounds such as snags and grasslands. It will be noticed that the safe limit of visibility is approximately the same in all directions. Curve B in Figure 4 represents corresponding visibility distances for smoke columns in direct sunlight.[7] Cloudy days have no appreciable effect on visibility distance if the smoke column appears against a dark background. Figure 4 represents conditions when the air is very clear; corresponding curves for hazy weather would show the same general characteristics, but all the circles would be proportionately smaller.

There are a number of days during each fire season when overcast sky conditions prevail. This may result from clouds of one kind or another, from "high fog", from a very high layer of smoke, or from some other condition of the upper atmosphere which prevents direct rays of the sun from reaching the ground. In regions or localities where such conditions are prevalent it may be worth while to base the fire detection system on the visibility distances characteristic of cloudy days. Many such days do occur in Washington and Oregon, but for various reasons it was decided to use as basis the visibility distances of smoke columns in sunlight. If this is done and cloudy days occur, it is safe to assume that visibility distances at least will not be shortened by the cloudy condition of the sky.

Increase in Size of Smoke Columns

Byram has shown[8] that the curves of visibility distance (Figures 2 and 3) for the standard size of smoke columns used in this study may be interpreted as being

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[6]For examples, average altitudes of the sun in degrees above the horizon for latitude 45° N. for May 21 to July 21 are: noon, 67°; 11 a.m. or 1 p.m., 63°; 10 a.m. or 2 p.m., 56°; 9 a.m. or 3 p.m., 47°; 8 a.m. or 4 p.m., 37°; 7 a.m. or 5 p.m., 26°; 6 a.m. or 6 p.m., 16°; 5 a.m. or 7 p.m., 6°.

[7]All curves in Figure 4 are for clear weather, against light backgrounds such as dry grass and snags, for 6:00 p.m., June 21, altitude of sun 16°.

[8]Reference previously cited.

distances of approximately equal visibility for smokes larger than the standard smoke column. Byram estimates that if a standard size smoke column can be seen at a distance of 14 miles, a column 4 times the standard diameter (64 times the volume) probably can be seen at a distance of slightly over 21 miles; if 6 times the diameter (216 times greater volume) it can be seen at about 24-25 miles; and if 8 times the diameter (512 times greater volume) it can be seen at about 26-27 miles. This estimation also is useful in indicating how much farther the small standard size of test smoke could be seen with binoculars than with the unaided eye. Thus, if the smaller smoke could be seen at 14 miles without artificial aid, it probably could be seen at 21 miles with 4-power binoculars, at 24 miles with 6-power, and at 26 miles with 8-power glasses.

Summary

Lookouts must be so located that fires will be discovered while small and can be controlled at minimum expense, but effective fire detection planning is impossible without definite information on the maximum "safe" limits of visibility for small columns of smoke. These limits vary with changes in certain physical factors external to the lookout. The more important of these factors are atmospheric conditions, brightness of backgrounds, position of sun relative to position of the smoke columns, size of smoke column, cloudiness of the sky, and whether or not the smoke column is in shadow or sunlight.

Field tests to determine the maximum safe limits of visibility were made with smoke columns of constant and known size. These tests were made, beginning in 1931, under a variety of the conditions listed above. The results so obtained were checked by laboratory experiments, by theoretical examination of the principles involved, and by statistical analyses of fire records. It appears that:

1. Small smoke columns can be seen farther when the observer is facing a low sun than when the observer has the sun at his back. (The reverse is true for trees, houses, and similar objects.)
2. Small smoke columns can be seen farther against dark backgrounds (e. g., green timber) than against light backgrounds such as grass and snags.
3. A curve of the maximum "safe" limits of visibility would be nearly circular. For dark backgrounds the observation point would be approximately at the center of this circle; for light backgrounds the observation point would be somewhat away from the true center of the circle, with the longer radii toward the sun. For all practical purposes "seen area" maps can be made circular.
4. Smoke columns can be seen farther on cloudy days than on clear days, the difference in visibility distance being greater against light backgrounds than against dark backgrounds. (Trees, etc., cannot be seen as far on cloudy days.)
5. For all practical purposes, the safe visibility distance of smoke columns in shadows appears to be zero when the observer must look toward a low sun.
6. Small changes in the size of a smoke column do not cause appreciable changes in its visibility distance.
7. In very clear weather small changes in atmospheric conditions result in large changes in visibility distance.

BRIEFER ARTICLES AND NOTES

Report of Summer Meeting of A. A. A. S.

The writer attended the meeting of the Council of the American Association for the Advancement of Science, at Rochester on June 16, as representative of the Society of American Foresters. The chief business consisted of the selection of places for future meetings. The 1936-37 winter meeting will be held at Atlantic City, December 28-January 1, with January 2 in Philadelphia, and the 1937 summer meeting is to be at Denver. Subsequent winter meetings down to and including 1944-45 are scheduled for Indianapolis, Richmond, Columbus (Ohio), New York, Washington, Dallas, and Chicago, in the order named. The 1938 summer meeting will be at Ottawa, Ont.; that of 1939 at Milwaukee, and of 1940 at either Seattle or Vancouver; and that of 1943 at the City of Mexico. For the 1941 and 1942 summer meetings no place has as yet been selected.

It was also voted to allow members of foreign societies of similar nature, such as the British Association, to join without payment of initiation fee, as is at present the case with affiliated societies like the S. A. F.

The program of the meetings was not too exacting to prevent three well attended field trips of the Ecological Society of America, one of them to a 250-acre tract of practically virgin beech-hemlock on the shore of Lake Ontario, owned by Mr. William B. Hale. The indoor meeting of this Society consisted of a symposium on The Scientific Aspects of Flood Control, held as a general meeting of the Association. Illustrated addresses were given by F. A. Silcox on Forests and Flood Control; Dr. W. C. Lowdermilk on Agricultural Land Use and Floods; and Morris L. Cooke, Administrator of the Rural Electrification Administration. In introducing the speakers Dr. W. S. Cooper, President of the Ecological Society of America, termed flood control a problem in human ecology, and all the speakers emphasized that great downstream engineering works were not enough, but that more attention should be paid the little waters at the sources. Just as the study of the life history of injurious insects may reveal vulnerable spots in their cycle, at which they are most susceptible of control, so the study of the life cycle of water indicates that the time when a raindrop strikes the ground is the time when it is most practicable for man to modify its action.

Other meetings of interest to foresters were those of the American Society of Plant Physiologists and the American Meteorological Society. Flood control figured also on the program of the latter society. Mr. W. E. K. Middleton, of the Meteorological Office, Toronto, read a paper on the theory of visibility, of interest to foresters concerned with forest fire lookouts. He showed how "extinction coefficients" were computed for different objects, and how colored objects become gray before disappearing. Only objects visible against a background of sky should be used in estimating visibility.

Evening lectures on color photography and airplane exploration of northern Canada drew large audiences; and visits were

made to the leading industrial plants and laboratories in Rochester. The luncheon given by Bausch and Lomb, at which the 250,000th microscope made by them was presented to Dr. Novy, was the climax of the meetings. The fiftieth anniversary of Sigma Xi was afterward celebrated at Ithaca.

HENRY I. BALDWIN,
Caroline A. Fox Research and Demonstration Forest.

AN AX FOR HACK-GIRDLING

The ax shown in Figure 1 is designed to hack-girdle undesirable hardwoods or other trees in a mixed stand. It has a thin blade 6 inches wide, and the cutting edge is concave. Its advantages over the standard ax with convex cutting edge in preliminary tests are that it girdles more circumference in one blow, and the woodsman does not have to change his standing position as often in circling the tree; the corners of the ax cut through the cambium and into the sapwood deeper; and the cuts overlap better.

The ax weighs 4 pounds, and is purposely heavy so that the woodsman can make short, accurate blows and still cut deeply enough to sever the cambium and penetrate the sapwood. The handle is straight and fairly thick, so that the ax does not flip in the hands. A previous design of 2¾ pounds with 4½-inch cutting edge and thin curved handle did not give so good results. The present type should prove effective on trees 5 inches and up. At the suggestion of the author, the Warren Ax and Tool Company, Warren, Pa., made up one for preliminary trials. Grinding, filing, or whetting should be no more difficult than with other axes. For cutting down 2- and 3-inch trees or shrubs it has the advantage of "fitting" the stem and "taking hold" better than a convex blade.

JOHN B. CUNO,
Forest Products Lab. U. S. Forest Service.

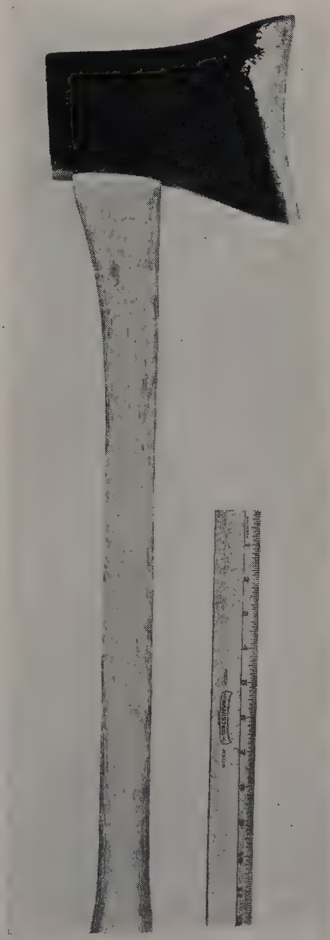

Fig. 1.—Design of girdling ax.

CAROLINE A. FOX FOREST RESEARCH FELLOWSHIP AWARDS FOR 1936

For the year beginning June 1, 1936, Dr. Richard G. Wood of Manchester, N. H., Alan A. Beetle of Hanover, N. H., and Livingston Lansing of Salisbury,

Conn., have been awarded fellowship grants from the trust fund established by the late Miss Caroline A. Fox and administered under the Fox Research Forest, in Hillsboro, N. H. Dr. Henry I. Baldwin, in charge of the Fox Forest, outlines the following projects to be undertaken:

Dr. Wood purposes writing a history of the lumber industry in New Hampshire from the earliest times of the broad arrow and ship-mast trade of Colonial days down to the present; he has recently published a similar "History of Lumbering in Maine". Mr. Beetle will make a thorough study of the vegetation of the Fox Forest in Hillsboro and vicinity, collecting, identifying, and mounting herbarium specimens of every plant encountered. It is also hoped that living specimens may be assembled in a garden where they can be preserved and demonstrated at any time. Mr. Lansing will make an investigation of the weather conditions at the time of and immediately preceding the most serious forest fires which have occurred in New Hampshire. He may also investigate the conditions leading up to years during which forest fires have been most destructive. It is hoped that these studies will supply a more accurate basis for forecasting when approaching conditions call for placing a ban on the woods by executive proclamation, as well as when extra precautions will be required by the forest fire service.

An Inexpensive Increment Core Holder

In order to handle in an orderly fashion, in both field and office, many hundreds of increment cores which have to undergo an examination involving shaving, staining, and growth analysis under a microscope, a core holder has been devised which allows free handling without individual numbering of the cores or the use of cement or paste which must be scraped off before examination. The holder, shown in Figure 1, is made of unbleached muslin, holds 50 cores, and costs about twenty cents at the local tailor shop if made up in any quantity. It is 6 inches wide by 20 inches long, and the individual pockets are 0.4 inches wide by 5 inches long. These pockets are numbered in pencil and the core from the correspondingly numbered tree inserted. The tab on the side, used to identify the set of cores, may be made of gummed linen and discarded when the holder is washed, or a more permanent style of file index tab may be used by clipping it to the holder and replacing the same one after washing the holder. The pencil numbers are removed by throwing the holders into the family washing machine. They do not shrink to any extent

When filled, the holder is rolled up with the tab exposed to identify the set of cores, and an elastic snapped around it. These rolls will stand ordinary handling without core breakage. When ready for growth analysis, the increment cores are easily removed by squeezing the lower end of the pocket. Broken or warped cores are best removed by increasing the increment borer's core puller.

For longer cores, of course, the cost

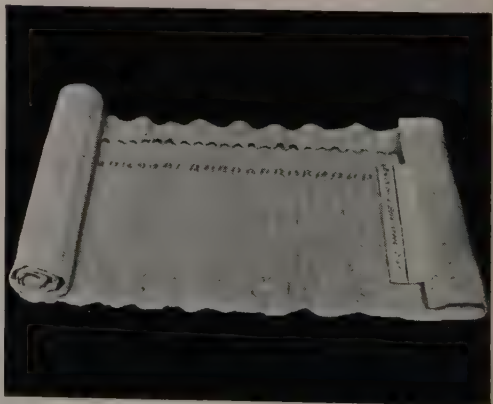

Fig. 1.—Unbleached muslin increment core holder.

of the holder would increase and the rolls would have to be handled more carefully. The type here described, however, has worked very well in both field and office.

R. F. Taylor,
U. S. Forest Service.

Further Notes on Measurement and Staining of Increment Cores

Preparation for a field project involving the analysis of growth of several thousand increment cores led to an investigation of shrinkage during the interval between boring the tree and examining growth in the office. This shrinkage has been referred to by others (1) (2) (4), but figures on amount of shrinkage and the error involved appear to be lacking. Staining of cores was also investigated.

SHRINKAGE

In March, before physiological activity began, 28 cores were taken from ponderosa pine of varying diameters, measured to the nearest 0.01 inch, and stored in the office at the usual room temperature and humidity. Periodic remeasurement showed no shrinkage after the first week. After 3 weeks the cores were soaked in tap water for 30 minutes, which resulted in swelling to beyond their original length.

The experiment was repeated with 25 ponderosa pine cores taken April 16, when sap was running freely. When shrinkage of these cores had stopped, they were soaked in water for successive periods until all had been soaked 2, 5, 10, 15, and 30 minutes. After each soaking they were remeasured.

Summary of data obtained.—The 28 cores taken March 3 shrank 0.0113 inch per linear inch of core in 7 days, at which time they ceased to shrink. After three weeks of drying, soaking for 30 minutes increased the length of the cores (per linear inch) to an average of 0.0185 inch more than they were at the time of boring.

The 25 cores taken April 17 shrank 0.0263 inch per linear inch in 9 days, thereafter shrinking no more. After 10 days of drying, when soaked for 2 minutes they were only 0.0008 inch shorter per linear inch than when taken from the tree. Longer soaking increased the cores to a length above normal, namely: 5 minutes, +0.0034 inch; 10 minutes, +0.0050; 15 minutes, +0.0051 inch; and 30 minutes, +0.0059 inch per linear inch of core length.

It thus appears that cores sent in from the field to be measured in the office several weeks later should not be soaked more than about 2 minutes for the most accurate results. The error involved per linear inch of tree *diameter* will then be approximately 0.0016 inch, or —0.024 inch for a tree 15 inches in diameter, breast high. An additional advantage of soaking is that cores warped in drying tend to straighten and become more flexible, spring and summer wood are more sharply defined, and the cores are shaved more readily with a razor blade (1) (5).

STAINING

Dry cores from very slow-growing ponderosa pine and lodgepole pine were dipped into a 5 per cent aqueous solution of phloroglucin and then into a dilute solution of hydrochloric acid (1 part concentrated acid and 2 parts water) as described by Stewart (5). This treatment stained the spring wood too deeply for ring counts, but shaving the cores brought the deeper stained summer wood into relief. Thorough water soaking before staining left the stained portion still too dark.

A dilution of the phloroglucin and acid in the proportion of one part each to one part water proved very successful in more sharply defining the summer

wood from the spring wood. Dry cores were stained very successfully with this dilute solution by dipping, quickly removing, and wiping them. Best results with green or soaked cores were obtained by leaving them in the dilute solution about 10 seconds.

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Rocky Mountain Forest and Range Experiment Station.

Wood Gas as a Motor Fuel

There appear in print at occasional intervals various conflicting reports concerning our future supply of liquid motor fuels. Some of these statements originate with individuals or organizations which have a commercial interest in the motor-fuel problem, while others represent the ideas of those who seek to anticipate future needs and provide a means for meeting them.

On May 13 and 14 the second annual conference of the so-called Farm Chemurgic Council was held in Detroit, Mich., and previous to the opening of its sessions two members of the Council granted an interview to the press in which they predicted a probable shortage of crude oil by 1940. They expressed the conviction that the possible crisis in liquid motor fuels would be averted through the industrialization of the American farm. The salvation of the fuel supply for internal combustion, according to them, rests on the production of fuel alcohol from surplus farm products. Important as alcohol production may be to the farmer's welfare and to the user of liquid motor fuels, we should not overlook the fact that there are other sources of power which will be available to us, and which may be of as great economic importance to the Nation as the use of surplus farm products for this purpose. I refer to wood gas particularly.

We seldom hear anything from foresters and conservationists about the importance of forests as a source of motor fuel, in spite of the fact that the possibilities along this line are very great. Central and northern European countries, which do not possess adequate supplies of crude oil and hence are forced to import the major part of their gasoline supply, have devoted much time and thought to the development of substitutes for liquid fuels which may be derived from domestic products.

Wood gas, produced from wood or charcoal in a special type of generator which forms a part of the motor equipment, has been shown to have great possibilities. As a fuel for stationery engines it has been used with satisfaction for nearly 50 years; but the idea of substituting it for liquid fuel for motor vehicles is a product of the early post-world-war days. Most of the experience with this type of fuel has been confined to converted gasoline engines, although various research workers have devoted much time during recent years to the development of a true wood-gas engine which is constructed in accordance with the specific requirements of this kind of fuel.

Although there still remain certain problems to be solved before wood gas

can be considered to be a fuel which is a satisfactory substitute for gasoline in motor vehicles, yet the developments to date have shown so much promise that many trucks and heavy passenger vehicles in Europe are now using wood gas, and the number is constantly increasing.

Among the advantages of wood gas for motor vehicles is its relative cheapness as compared to liquid fuels. German authorities state that 21 pounds of air-dry beech wood or 10.5 pounds of beech charcoal are equivalent to 1 U. S. gallon of gasoline, and that a 10-ton truck, with a full load, will consume from 350 to 420 pounds of wood, or from 175 to 210 pounds of charcoal, per 100 miles travel. Assuming that, in this country, prepared wood costs $15 per cord of 4,000 pounds, and charcoal 0.8 cents per pound, the total fuel cost for 100 miles for wood would be from $1.31 to $1.57, and for charcoal from $1.40 to $1.68, as compared to $2.89 to $3.40 for gasoline costing 17 cents per gallon. The saving by the use either of charcoal or of wood is more than one-half. Against this saving must be balanced the disadvantages of the use of wood gas which exist at present, namely, the reduction in motor output, as compared to gasoline, the necessity for cleaning the filters daily (requires from 10 to 15 minutes), cleaning the generator after 1,200 miles travel (requires about 1 hour's time) the period of heating necessary to produce sufficient gas to drive the engine when starting with a cold generator (6 to 10 minutes), and the weight of the equipment.

Improvements now being made will increase the motor output and reduce the weight of the generator and other equipment, but will not eliminate the necessity for cleaning the filters and generator. These disadvantages, however, particularly in truck operation, will be more than offset by the reduced cost of operation.

Although it is not probable that in this country interest in the use of wood gas will be aroused to the point where it is widely adopted as a motor fuel until gasoline becomes higher in price than it is today, yet as foresters we should not overlook the opportunity to point out forcibly that forests will provide a future satisfactory substitute for liquid motor fuels which is renewable and hence inexhaustible. The promotion of this idea will present an excellent opportunity to aid in making the vast army of motor vehicle users *forest conscious*, many of whom can be reached only through pocket book savings. Why not equip a few of the thousands of government trucks now employed in forest work with wood-gas equipment, thus providing an ocular means for creating an increased interest in forestry as a national asset and likewise learning, by experience, what further developments are essential in order to adapt this type of fuel to our conditions?

R. C. Bryant,
Yale School of Forestry.

Unusual Longleaf Pine Seedlings

Foresters are familiar with some of the peculiarities of longleaf pine. For instance, one cannot always tell with any degree of definiteness the age of a naturally regenerated longleaf pine seedling or sapling unless one had it under observation since the cotyledon stage. The fire-resisting quality of longleaf pine is not unknown in the South. The peculiar growth conditions of longleaf pine seedlings which cause them to be almost indistinguishable from the surrounding grasses for a period of years are familiar to those who have worked with this species. Seedlings which are over eight years old and still in the grass are not uncommon in the South. Longleaf pine,

therefore, is unlike other species of southern pines.

A very rare condition has recently been observed on an experimental plot in Washington Parish, La. There, in plots denuded of all vegetation except longleaf pine seedlings, which were spaced in densities of 1, 5, and 10 per milacre and which are now in the sixteenth growing season, seedlings about one foot high are already bearing cones. Four of the seedlings are about one foot high, measuring from root collar to tip of bud, and one is four feet high bearing its two cones on a lateral branch one foot below the tip of the terminal bud. So far as I know, this is the first case on record where longleaf pine seedlings which have just started height growth are already bearing cones.

L. J. PESSIN,
Southern Forest Experiment Station.

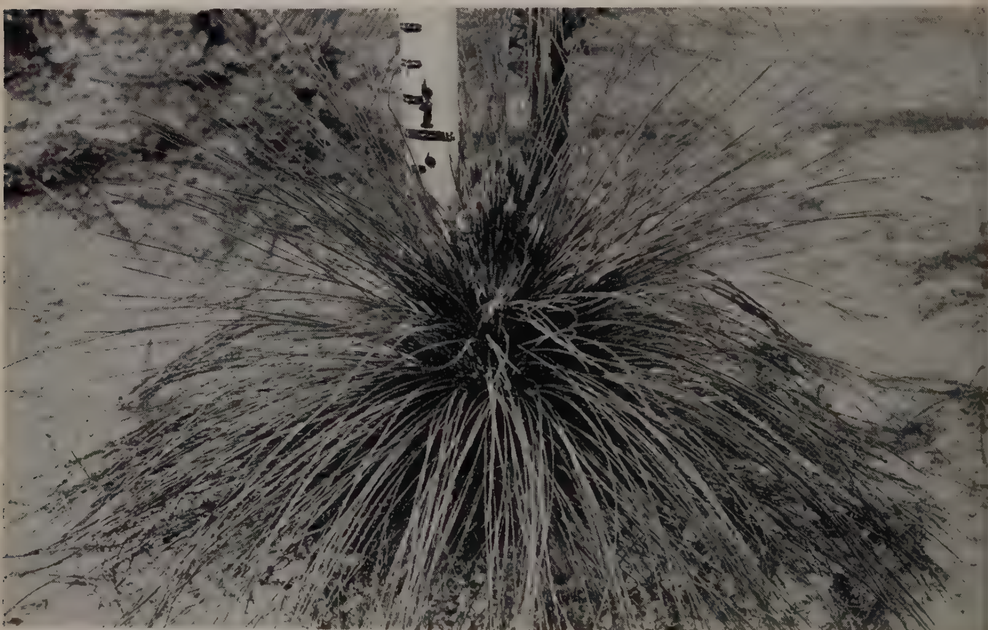

Fig. 1.—Longleaf pine seedling 15 years old and nine-tenths of a foot high, bearing two pistillate cones.

REVIEWS

Forest Taxation in the United States. By Fred Rogers Fairchild and Associates. *U. S. Dept. Agric. Misc. Pub. 218. Pp. 681. Government Printing Office, Washington, D. C. 1935. Price 75 cents.*

This, the final report of the Forest Taxation Inquiry, has been awaited for many months by those who have read the several progress reports. It does not entirely supplant these reports, as it is in large measure a condensation of the material they contain.

This investigation is in a class by itself. Rarely if ever has a taxation inquiry been conducted, if an outsider may venture an opinion, under more favorable auspices. Growing out of an economic maladjustment in the forest industry visible to all but the wholly blind, more or less agitated for more than a quarter-century, the subject of forest taxation attracted the attention not only of organizations interested in forestry as a technical and social problem but also of the National Tax Association, thereby gaining the good will of most students of taxation and the opposition of none. The ground was prepared by a nation-wide survey of the Senate Committee on Reforestation in 1923, whose recommendations led, in 1924, to the Clarke-McNary Act, under which the Secretary of Agriculture was authorized to initiate the Inquiry.

The investigation was, moreover, limited in scope to the effects of tax laws upon forest growing, although it was found that almost all aspects of taxation have a bearing thereon. Gotten under way in 1926, the Inquiry now presents its report, after ten years of work. This leisurely procedure contrasts sharply with the haste that usually characterizes the work of such commissions, whose studies must usually be completed before, and reported to, the next legislative session. It made possible a comprehensiveness of investigation and ripeness of conclusions not otherwise attainable.

But this is not all. In charge of the investigation was placed an economist who is probably the foremost authority on forest taxation in the country. The location of headquarters at an established school of forestry, and the ample facilities therewith made available, must have aided the project materially. There was also the prestige and financial support of the national government, able to command the services of experts of this country and some from abroad, plus such services as were delegated from the Forest Service. The Inquiry enlisted the support and cooperation of state and local governments and institutions, as well as of industries related to forestry.

Although therefore much was expected, the results are not disappointing. Forest taxation is studied in its setting, which means that not only are particular taxes relating to forests investigated, but the entire fiscal system of national, state, and local governments. The so-called general property tax absorbs most of the attention, for that is the tax most intimately affecting forestry. Without it, there would have been no need for the Inquiry. Assessment, collection, and delinquency are discussed fully, and the tax receives the usual amount of adverse criticism. It also receives a great deal of critical analysis, which is unusual in the conventional taxation inquiries.

The outstanding feature of the report is Part 3, which deals with the theory of forest taxation, with special reference to the property tax. This tax is based upon capital value, which in turn, under the doctrine of capitalization, is based upon the anticipated incomes from the property. Forest property, except in case of old-growth forests, is property yielding a deferred return. Because the property tax is levied repeatedly on the present value of future incomes, which must necessarily be long deferred, the tax takes a larger share of the income (before the tax) than would be the case if the same return were received on an annual sustained basis. This discrimination against forest property is demonstrated by means of lengthy mathematical formulae, which however are not particularly difficult. The fact as to the effects of a capital-value tax on deferred-yield assets is not newly discovered, but it is not commonly understood by students of taxation. It is to be hoped that the formulae of Part 3 will do what common sense ought long ago to have demonstrated.

As far as the forest industries are concerned, the effect of this tax discrimination is to interfere with the economical apportionment of the factors of production. It has fostered mismanagement of old-growth forests and, what is more important now, has discouraged the growing of forests on second-growth or cutover land. The tax has operated to offset the movement and the efforts for conservation of forest assets.

It is proposed to cure this discrimination by eliminating the excess tax which is due to the deferment of yield. The first and probably the most difficult remedy proposed is the so-called modified property tax, which would do directly what is desired, namely, eliminate the tax on that part of the value of the property which is due to the deferment of yield. In practice, the computation of the amount of the valuation thus to be deducted from the assessed value would be arbitrary and complicated, too much so for local administration. The second proposal, the deferred timber tax, would defer the tax on the timber, but not on the land, until after the realization of a yield, at which time the deferred timber tax would be payable without interest. This scheme would require a state fund to equalize temporarily the revenues to the local treasuries; for the income cycle in a small governmental unit would operate simultaneously on all of the owners of forest property, with wide variations in the cash revenue received by the local treasury or intolerable variations in the taxes on nonforest property. The third proposal, the differential timber tax, is the simplest of the three; but it is a compromise of principle sacrificed to simplicity. It would assess the timber and the land separately, and tax the former at a lower rate, or on a lower valuation, the reduction factor to be uniform for the entire state and based as nearly as may be upon the excess tax paid on forest property. Nearly all of the present adjustments, such as exemptions, rebates, and yield taxes, the Inquiry refused to recommend.

At first blush it might seem that the submission of these three alternative remedies is a small product for a ten-year study, particularly so since the adoption of any of them is at best problematical. All that is needed to convince any doubter of the worthwhileness of the Inquiry is for him to read the report. What has been recommended, as positive measures, is all that the situation warrants. It is as important to demonstrate the unsoundness as the soundness of measures in force and proposed. The Inquiry is to be commended for its restraints. If the grist of positive measures directly related to the general property tax seems small, the reason is perhaps to be found in the recalcitrancy of the situation itself.

The Inquiry took for granted the "fundamental American social and political

institutions as they exist at present". In this respect there was, of course, not much choice. Adjustments in taxation are consequently limited to changes in form of the property tax. Here is the dilemma which the Inquiry had to face. The report states that "the search for a just tax begins with the presumption against special favors to forest owners." One key to the situation is given in the sentence immediately following: "Nevertheless, consideration of the use of special favors for the purpose of encouraging forestry has not been excluded from this investigation." The fact is that any of the three alternative recommended measures will inevitably favor the present forest owners by increasing the tax-clear income from their holdings, and thereby increasing the capital value thereof, according to the formulae of Part 3 of the report. It can scarcely be said that the forest owners by their behavior so far have earned this increment. If they are to receive it, this must be on the ground that the stimulus to forest growing which the recommended measures will give cannot be had on other terms. The Inquiry evidently concluded that such a gift was warranted; and in view of the conditions accepted as basic for the study, it was probably correct. Doubtless the Inquiry was also aware of the possibility that the increment might be handed to present owners in such a way as to result in very little stimulus to the growing of forests. The merit of the report is that it brings this dilemma out into the open, for all who can read.

The Inquiry has other attainments to its credit. It has presented an excellent analysis of the general property tax, as a part of the setting for the property tax on forests. It has in fact presented mature conclusions on practically all matters usually investigated by the conventional taxation inquiry commission. But these things are all focussed on forest taxation. The investigation is decidedly a proper and meritorious governmental service. It would be well if similar inquiries could be undertaken relative to the taxation of other natural resources, notably coal, oil, and water power.

JENS P. JENSEN,[1]
University of Kansas.

A review of a publication of this size can naturally only hit a few of the high spots. Any one of its twelve parts would make a good-sized bulletin. These cover the following subjects:

Introduction; financial organization of government in the United States; theory of forest taxation, with special reference to the property tax; the property tax—assessment and apportionment; the property tax—collection and delinquency; forests in the property tax base; the property tax burden and its effects on forest management; the absolute burden of taxation as controlled by governmental organization and functioning; special forest-tax legislation; other taxes in relation to forestry; taxation of forests in northwestern Europe; the forest-tax problem and its solution.

The authors stress the desirability of decreasing the cost of government through greater efficiency, better personnel, and consolidation of local political units. Five methods of forest taxation are discussed, namely, the yield tax, immature timber exemption, the adjusted property tax, the deferred timber tax, and the differential timber tax.

The yield tax and immature timber exemption are not recommended because of difficulties of administration, as well

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[1]Mr. Jensen is professor of economics at the University of Kansas, author of "Property Taxation in the United States" (University of Chicago Press, 1931), and an outstanding authority in the field of taxation.—*Ed.*

as the fact that, in some regions, these methods would decrease the tax income to such an extent that the local governments could not function.

The three methods which are recommended are all modifications of the property tax. The adjusted property tax would reduce the current property tax on the deferred-yield forest property by an amount proportioned to the extent of income deferment in each individual case. The deferred timber tax would defer the payment of property taxes until income is received, and the state would pay the taxes to the local units of government until the forest properties come into production. The differential timber tax would apply a flat-rate reduction to the property tax based on the degree of income deferment which may be considered typical or average for the state.

In checking over the descriptions of the recommended methods and the examples shown, one is struck by the small amount of tax relief that would be given over a period of years. As these methods are based on the property tax, which, after all, is subject to the frailties of human judgment, a slight change in the assessed value or the tax rate would tend to nullify any adjustments made. Pressure for more taxes in local units of government is apt to occur from time to time. It therefore appears that the tax relief of the recommended methods of taxation would be subject to nullification unless there were a complete reform of our local governments and tax systems.

It is realized that the report stresses tax reform; however, there is danger that the three proposed methods will be advocated for adoption prior to a general reform. By general reform is meant, briefly, consolidation of local governments, scientific assessment of all natural resources on a statewide basis, the employment of efficient personnel, and efficient collection of taxes. Efforts might better be directed toward permanent tax reform rather than toward adoption of the proposed methods, which are dependent on the administration of the property tax. In case one of the three methods should be adopted prior to general reform the relief obtained could be largely nullified through changes in assessment of forest property or through increased taxation of other kinds of property owned by the same taxpayer. In case the general reform came first, a permanent reduction in taxes would result which would probably afford more relief than the proposed plans. In this case the adoption of one of the three proposed methods might not be necessary.

The large operating corporations which are the most likely to practice sustained yield would not get much benefit from the proposed plans, as the major portion of their taxable property would be of a kind which is subject to the ordinary property tax. The bulk of the property would be in operating blocks of timber, plants, railroads, and in many cases also agricultural land. It would be much more advantageous for these organizations to use every effort to bring about a general tax reform which would apply to their various kinds of property, rather than to get a small amount of tax relief on some nonoperating timber or young growth.

Many other factors besides taxes are important in the practice of sustained-yield forestry. A small amount of tax relief on a minor portion of the property of a large corporation would, after all, have very little effect in the determination of a final policy as to whether it would practice forestry or not.

General tax reform and a decrease in the cost of government would be an objective which would have a far-reaching effect on all business. With this accomplished, the taxation of forests could be put into its proper place in our taxing system.

Unquestionably, the Taxation Inquiry has done a very thorough job of fact finding on the tax problem. The results

are undoubtedly correct from a theoretical standpoint. If there is an error, it is one in emphasis. General reform is prerequisite to the ultimate solution, and if it comes first, the proposed modifications of the property tax may then be superimposed. The danger is that the process will be reversed. In this case the progress of general reform will be greatly impeded and no worthwhile result will be attained. It is realized that this viewpoint is one of individual judgment or opinion, and in no way reflects on the recommendations of the publication.

The Taxation Inquiry has rendered a great service, in that it has compiled under one cover not only the data which it collected, but also all other important information in the forest tax field. This publication will serve as a tax encyclopedia to students and all others who desire to study this difficult problem.

The information submitted has been worked out with painstaking care as to detail and accuracy. A foundation has been laid in forest tax information for the United States which is invaluable, and which will undoubtedly be the basis of an ultimate solution to the entire problem.

E. T. F. Wohlenberg,
Internal Revenue Service.

Wood Handbook. Basic Information on Wood as a Material of Construction with Data for Its Use in Design and Specification. By Forest Products Laboratory, Forest Research, Forest Service, U. S. Dept. Agric. *325 pp. Illus. Government Printing Office, Washington. 1935. Price 25 cents.*

Wood in consumption has suffered from misuse and abuse far more than from any lack of inherent qualities or superiorities over other materials of construction. To help to correct this situation there has been an urgent need for many years of an authoritative manual on the material itself, the properties of the various commercial species, and their comparative behavior in service. A number of books intended for this purpose have been published from time to time, but more as textbooks than for the everyday specifier and user of lumber and timber. The Wood Handbook issued by the Forest Products Laboratory now makes available the sort of a manual that has been needed by both the professions and the trades concerned in any kind of construction.

The Laboratory has brought between two covers practically all the useful data resulting from its research of more than 25 years on the physical and mechanical properties of wood, that may be considered, in the words of the subtitle, "basic information on wood as a material of construction, with data for its use in design and specification". It goes beyond these uses in some respects, and provides much useful information for the industrial fabricator of wood products.

The titles of the chapters clearly indicate the kind of data the book contains: Glossary of terms; structure of wood; characteristics of some important commercial woods; physical properties of wood; strength values of clear wood and related factors; grades and sizes of lumber; structural timbers; timber fastenings; wood beams, columns, and arches; glued wood construction; bent wood members; control of moisture content and shrinkage of wood; fire resistance of wood construction; painting and finishing wood; protection against wood-destroying organisms; wood preservation; poles, piling, and ties; and thermal insulation. There is a complete index to the properties, characteristics, methods of treatment, uses, and design of any wood, and to associated construction materials such as timber connectors, nails, screws, and paint.

The intricate aspects of wood in all

its construction uses are presented in a manner that is above the average for a government publication. By this is meant that the style of writing used is a happy combination of purely technical and purely practical or popular. It is so written that it will appeal to the engineer, architect, and other professional specifier and user of wood as sufficiently scientific to meet his purposes and whims. At the same time most of the information is not put up in a manner that places it over the head of the practical carpenter, builder, contractor, or layman without professional training. It is also commended to those units in federal, state, and city governments which are required to issue purchase and construction specifications and which have been notoriously poor in these lines.

Before inaugurating ten years ago and spending huge sums of money in trade promotion, the lumber industry should have used a part of its funds in the publication and distribution of an all-species handbook of this character which all of the individual units in the industry could have used in promotion and selling. Destructive inter-species competition would not then have turned so many markets to other materials. Had the industry done this, there possibly would have been no need for this government handbook. Or perhaps the Wood Handbook would not have contained certain information that the lumber industry now will not like. On the other hand, there are some data in the Laboratory handbook that are too conservative for the future good of wood, some that appear to dodge the issue, and some that had to be treated too briefly because of lack of knowledge or space.

By and large, however, this publication is the best of its kind available from any source, and will prove to be one of the most useful publications ever issued by the Forest Service. The fact that the Superintendent of Documents cannot keep the printing of this handbook ahead of the orders is early indication of that.

While aimed primarily toward the wood-specifying and consuming groups and individuals, the manual should not be overlooked by the silviculturist. He will find in it knowledge he ought to have and use in deciding what kind of wood to grow, how slow or how fast to grow it, species in greatest demand, and those most efficient for his local industries. The fact is, more forest products utilization knowledge should be put to work in our silvical research and public and private timber-cutting policies.

ARTHUR UPSON,
Southwestern Forest and Range Experiment Station.

Selective Timber Management in the Douglas Fir Region. By Burt P. Kirkland and Axel J. F. Brandstrom. *122 pp., 16 pl., 20 figs. Publication financed by the Charles Lathrop Pack Forestry Foundation, Washington, D. C. 1936.*

"The purpose of this report is to demonstrate through detailed studies of representative timber areas the wide possibilities that now exist for bringing the timber lands of the Douglas fir region under intensive selective management so that they will provide abundant and continuous supplies of high-quality products."

The previously published works of the junior author and other writers have demonstrated the practicability of changing past methods of logging in the heavy timber stands of the West so as to permit relatively light cuts and relatively frequent returns. In the present publication these facts are applied in the development of a plan for sustained yield management of the forests in the Pacific Northwest. The authors assert that such

management is now practicable and will in fact give better financial results than the usual method of extensive clear cutting.

The existence of an adequate growing stock of timber, much of it of high quality, is the factor, together with the practicability of comparatively light and frequent cuts, which makes possible immediate, profitable adoption of the changes proposed.

Another high light of the publication is the emphasis which the authors place upon the continuous production of high-quality material, which they claim is a necessary management objective if the export markets for the Pacific Northwest timber are to be retained. High-quality timber should form approximately one-half of the future cut, and will require 150 to 200 years for its growth. It is admitted that the lower grades can be grown in other forest regions better situated with respect to consuming centers and hence likely to undersell the Pacific Northwest.

As a medium for focusing the attention of lumbermen and timberland owners in the Douglas fir region upon the attractive opportunities for placing timber growing and utilization on a permanent and profitable basis, this report is unexcelled. Foresters within this region, whether private, state, or federal, might well devote their energies principally to obtaining application in the woods of the ideas set forth by Kirkland and Brandstrom. The chance exists, if seized soon, because of its superior growing stock, for the Douglas fir region to insure permanency to its timber industry. The question now is: Will the vaunted energy and efficiency of the Pacific Northwest be sufficient to act aggressively on the opportunities offered?

From the technical standpoint, it may be of interest to comment upon a number of points. In the beginning the authors very commendably hasten to assure the reader that their doctrine has nothing in common with "economic selection", which in recent years has found considerable use in the western forests.

"Selective timber management" evidently is quite different, but an exact definition of the term is hard to find in the publication. The authors should have furnished us with a clear-cut definition if it was necessary that another new term should be created. When the report has been read, it becomes clear that "selective timber management" in the Douglas fir region is simply "timber management" or "timberland management" or "forest management" in the Douglas fir region, since it embraces all angles of forest management, from timber estimating to record keeping. "Selective" has been tacked on to make the methods stand out in contrast to the clear-cutting method in large blocks, customarily used in the region, and probably also to get the benefit of the educational work already done along the line of "selective logging" when conservatively used. Both of these are good reasons for adding "selective" to the title of this publication for its effect upon the timberland owner and operator.

It is also true that the authors have in mind as part of their plan a group-selection system of cutting, the groups cut clear preferably being 1 to 10 acres in size and the area so cut amounting each year to not more than 0.5 per cent of the whole area. However, such a large share of the detailed procedure of the intensive operations proposed could be carried out under either shelterwood or clear cutting, as well as under selection methods, that it seems unnecessary for the professional forester to restrict the title of this publication by the term selective. All intensive forest crop production is "selective" in the sense that individual trees are removed from the various stands from time to time for a variety of reasons; but, if the word is

used in its technical meaning, it carries the implication of the selection method. Intensive application of the clear-cutting method in small-sized units can give sustained yield as well as selection cuttings. The possibilities along this line are hard to visualize when dealing with such a crude method of cutting as extensive clear cutting in the Pacific Northwest.

The authors have recommended a very intensive type of treatment in suggesting that Biolley's ideas be applied to the unmanaged forests of the Northwest, and it remains to be seen how successful may be the application.

The authors realize their vulnerability in advocating operations in such full detail, and have amply protected themselves by admitting that the correct detailed procedures must be learned by experience and may be different from those they now advocate. General knowledge as to the ecology of the various forest types and species in the Douglas fir region is needed before the best application of cuttings can be determined. *The authors are interested primarily in emphasizing the idea that sustained yield is now practicable, and that a good percentage of high-quality timber should be grown. The great value of the report lies in the demonstration of these ideas.*

Taken as a whole, this publication is one of the most noteworthy which has appeared in recent years; and the authors are to be congratulated upon their grasp of the subject and the manner of presentation. The report is commended to all our readers for careful perusal. The 16 pages of excellent illustrations add appreciably to the value of the work.

It is to be hoped that this report may have influence upon the character of cuttings made on timber sale areas in the National Forests.

R. C. Hawley,
Yale School of Forestry.

The principles of selective timber management are often considered to be peculiarly, if not exclusively, applicable to many-aged forests of tolerant or semi-tolerant species. Adoption of selective management plans for large areas of old-growth timber has been considered unwise from the silvicultural standpoint and impractical from that of logging, especially when dense stands of large timber have to be handled. We may still have to contend with unsolved silvicultural problems, but the crawler tractor and arch have solved the logging problem; and selective logging, if not selective timber management, has invaded the Douglas fir region and seems likely to displace cable-logging methods over large areas. This publication, in its attempt to direct the further development of selective logging practice in the Douglas fir region along lines which will perpetuate the forest resource, is very timely and deserves the careful attention of all who are interested in the future of the forest industry where heavy and often overmature stands of timber have to be handled.

The authors rest their case for selective timber management in the Douglas fir region upon three major points, namely:

1. That the perpetuation of existing resources and investment values is contingent upon continuing supplies of large, high-quality timber;

2. That selective timber management will yield the highest returns from forest properties;

3. That the rapid extension of logging over an entire management unit will bring about effective control of the forest through the development of necessary transportation facilities to such an extent that the problems of forest protection can be dealt with in an economical and efficient manner.

It is sufficiently evident that the Pacific Northwest owes its predominant position in the forest industry to its supplies of large, high-quality timber. The growth rate in this region is possibly comparable

to that in the South; but the fact remains that the original growing stock of the southern forests has been largely removed, and that we cannot expect again to see large quantities of high-quality timber produced there. However, the South has the advantage of proximity to markets, exceptional productivity even on poor sites, easy logging problems, and cheap labor. On the basis of productivity alone, the South can and will force all other producers of medium- and low-quality timber out of the markets of the eastern United States. If the Pacific Northwest is to compete for its share of domestic and foreign timber markets, it must to a large extent rely upon the existing volume of high-quality growing stock and not upon its capacity to grow cubic feet per acre from scratch, regardless of whether that capacity be greater than, less than, or on a par with that of the South. It may, therefore, be conceded that any system of management which will perpetuate the existing high-quality stands of the Northwest, or for that matter any other region in the United States, is one that should be striven for.

That the system of selective timber management proposed by the authors can be relied upon to achieve this end is a matter which many foresters and lumbermen are disposed to challenge. It is contended that the system will result merely in the gradual removal of high-quality timber which will command a relatively high price on present depressed markets, but that it does not assure the permanence of high-quality growing stock with continuing high-quality yields. The opponents of the system point out that Douglas fir will probably not regenerate under such a system of cutting, and that there is a danger of high-grading which will result in a depreciation of stands from the value standpoint, if not from that of volume. In other words, that the system will create a new type of forest, composed largely of inferior species such as western hemlock, which may have the volume and to some extent the size characteristics of the original Douglas fir forest, without corresponding quality and value.

It cannot be denied that this is a danger, and one that should not be lightly passed over. On the other hand, it must be admitted that systems of logging hitherto almost universal have too often left behind them no forests of any description, so that we now face the problem of starting again to raise on bare land a new forest of such species as we may think the market will require and which we think we know how to raise. Certainly present systems of management do not put owners of high-quality growing stock in a position to maintain this on a dimensional basis. Doubtless we should be able to raise Douglas fir or any other species suited to the soil and climate, with satisfactory results from the standpoint of mean annual cubic-foot production. This hardly seems enough. The quality that goes with size will always be lacking in stands which are brought in on bare land. It is quite possible that the production of large-sized hemlock may be more profitable fifty years hence than that of medium-sized Douglas fir and spruce. Moreover, it is by no means certain that the more valuable species cannot be perpetuated under the system proposed, although the silvicultural difficulties in the way of such perpetuation may at present appear to be a sufficient reason for adhering to clear-cutting methods with regeneration of the more desirable species.

The second point upon which the case for selective timber management appears to rest, namely, that such management would yield the highest return from a majority of forest properties, is the one upon which the authors have laid the greatest stress and with which they have dealt most adequately. In Chapters 1 and 2 they sketch the economic aspects of timber production in the Pacific Northwest and the cost and value factors upon

which they rest their major case, which is presented in Chapter 3. In this latter chapter the financial advantages of selective timber management versus straight liquidation are presented in a clear and convincing manner. The forest property which they have selected for illustrative purposes is perhaps not typical of conditions in the region as a whole; but it is very doubtful if a typical case could be cited. Giving consideration only to the data presented, the case for selective timber management as set forth in this chapter appears irrefutable. The chapter demonstrates clearly and logically that where there is any reasonable range of sizes and values in a tract of timber, modern methods of logging and milling make selective cutting the sole means of realizing the highest values from the tract. The data are clearly and logically presented, and a difficult subject is clearly and convincingly dealt with. Here are presented the dollars and cents arguments which go to justify the other conclusions of the study, and it is possible that the whole report would have been strengthened if the authors had rested their case for the financial side of their argument at this point without adding the interesting although debatable and nonconclusive discussion which is contained in Chapters 4 and 5.

Chapter 3 does not make out a sound case for sustained yield. One gets the impression that sustained yield, if it comes at all under selective management, will be a byproduct of a new method of liquidation. It is to be regretted that this impression should be conveyed by this otherwise satisfactory financial presentation. However, it is very probable that sustained yield on private property actually will, in nine cases out of ten, be a byproduct of a conservative method of liquidation, and lacking more definite information upon rates of growth and possibilities of regeneration, it is difficult to see how the authors could have dealt differently with the case they have presented. By some it may be contended that they merely make a case for a high-grading system of logging which timber owners will use to justify operations aimed only at liquidation and not at sustained yield. Some operators may do just this; but it hardly seems reasonable to believe that they would refrain from high-grading merely because they lacked arguments to prove that it simulated sustained yield practice. Modern methods make high-grading profitable; therefore why not lead high-grading in the direction of sustained yield?

The third point made by the authors, namely, that the control of the forest brought about by the rapid extension of transportation facilities over an entire property is an essential concomitant of a selective plan of management, is perhaps as important as any from the standpoint of sustained yield practice. Selective management is challenged not only upon silvicultural grounds but also upon the ground that it will increase the hazards from fire, insects, and disease. Those who offer this challenge seem to forget that these hazards are always with us, and that they take toll in many instances through lack of possibility of salvage. The authors rightly contend that the rapid spread of logging operations over an entire unit will quickly remove from the stands static and declining timber values, and that thereafter, as incipient deterioration from insects or disease becomes apparent, the existing road systems will permit a flexibility in logging operations which will make possible efficient and economical control. They likewise contend that, although the fire hazard may in some instances be increased under this system through the impossibility of removing slash by a clean burn, still, where such conditions obtain, the existence of a road system will more than offset the increased hazard. They contend further that in most instances the light cuts called for under their system will preserve the forest climate and there-

fore actually decrease the fire hazard, even though some slash remains on the ground. These are of course debatable points and not susceptible to immediate proof; but the advantages that go with flexible, rapid-moving logging units and an extensive road system cannot be denied.

One further hazard which is not adequately dealt with is that of wind. With the light selective cuts which are proposed it is possible that stands will become sufficiently wind-firm as logging proceeds so that little loss will be occasioned by wind-throw. On the other hand it is to be doubted that the average operator will confine his first cut to a volume the removal of which would not endanger the remaining stand, and there are probably many areas which are subject to such hazards of wind as would make the proposed system impractical.

Chapters 8 and 9 deal with the organization and administrative control of logging and timber management operations. Useful forms of record keeping are presented, and the technique of cost keeping is discussed to some extent. The utility of a continuous inventory of the timber stands coupled with accurate cost records is demonstrated, and these chapters should be of interest to any timber operator, regardless of the plan of management he may adopt.

The authors stress the fact that the selective management method is continuously experimental, in that it relies on the experience of the past, especially the immediate past, to guide the future.

This is a most important point, and should be kept in mind at all times when the merits of selective timber management are being considered. The great advantage of the method is that one is not irrevocably committed to it after adoption, as is so often the case when methods calling for heavy investment in plant and equipment are initiated. When this fact is appreciated, many of the doubts as to the wisdom of adopting the method can be set at rest. At no point throughout the report does one get the impression that it represents a final statement. New methods of logging are rapidly being adopted, and new methods of timber management are an inevitable corollary. Selective timber management should be tried out experimentally, and molded to meet changing conditions within the forest and on the timber market as operations proceed. The possibility of following such a course with this method seems greater than with alternative methods, and the way is always open to a shift to other methods of logging and management if and when experience points in that direction.

D. M. Matthews,
University of Michigan.

CORRESPONDENCE

Editor, JOURNAL:

The report of the Committee on Land Policy of the Allegheny Section in the May issue of the JOURNAL, page 503, is an excellent statement of the basic considerations which should be observed in developing forestry to its greatest usefulness. The Committee obviously gave the subject of land policy with reference to forestry a very careful and thorough analysis, uninfluenced by the many and diverse proposals, schemes, and plans, hastily conceived, for the expansion of forestry in the United States. Absolutely sound in its premises and logical in its conclusions, the report might well be accepted as a statement of fundamental policy for the Society as a whole. I commend it to the membership of the Society as at least one report which should be very carefully read.

I am advised by Mr. John F. Preston, Chairman of the Committee, that the report was submitted to the last meeting of the Allegheny Section and was accepted. The other members of the Committee were: Alfred Ackerman, L. S. Altpeter, E. O. Ehrhart, L. S. Gross, J. W. Keller, F. T. Murphy, T. W. Skuce, and C. P. Wilber.

A. E. WACKERMAN,
Southern Pine Association.

Editor, JOURNAL:

I wish cordially to endorse the statement by Robert Marshall, Chief Forester for the U. S. Indian Service, in his praise of the efficiency of the technical force which has, over a period of many years, built up an efficient administration not only of Indian Forests, but has recently, through merit, acquired a unified control over both forests and grazing on Indian Reservations, thus achieving the same territorial unity of management of these two resources on the reservations as is inherent in National Forest Administration.

I would like to add, though Mr. Marshall does not discuss it, a word of equal appreciation for the technical force of the National Park Service, containing many trained foresters. For over 20 years I have actively participated in park work as a member, since 1917, of the State Park Commission of Connecticut, and in defense of the inviolability of National Parks against commercial inroads.

I do not believe that these trained men desire or approve of political appointments, whether they are in one branch of the government or another, and shall continue, for the Society, to oppose the spoils system wherever it is found.

Neither do I believe that the Department of the Interior as a Department should receive by transfer the control of biological resources allied with agriculture, namely the National Forests, Biological Survey, or other such agencies, and, for the Society, I shall continue to oppose the efforts of Mr. Ickes to constitute the Department of the Interior the sole conservation agency of the Government.

On the contrary, I believe that the grazing resources on the Public Domain have been transferred to the Department of Agriculture 20 years ago, and that such transfer alone will offer a sound, centralized administration of grazing, and I shall, for the Society, work for this end in the passage of the Kleberg Bill.

H. H. CHAPMAN,
President.

Errata

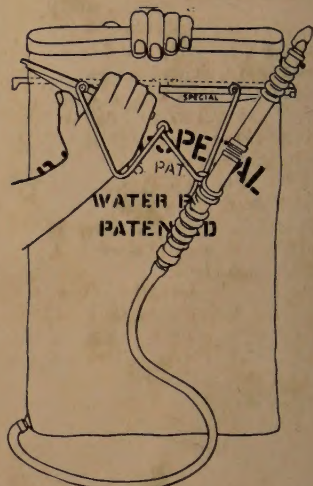
The Hester Plow Company advertisement on page 644 of the June Journal read in part: "For fighting going fires, the .... Plow can be loaded on the same truck with the tractor, provided the truck body is 5½ feet longer than the tractor." The Company requests attention to the fact that its advertisement should have read "3½ feet longer," not 5½. Correction of the error in the original form furnished by the Company was received too late for altering the figures as published in June.

The senior author of "Forest Fire Damage in the Northeast—III, Relation Between Fire Injury and Fungal Infection," an article published in the April, 1936, Journal (Volume 34, pages 420-23) calls attention to a glaring printer's error in Table 2 (page 421). Under "Oak Cover Type", six species, all hardwoods, were listed as the hosts of certain fungi; but they were captioned "coniferous hosts". The authors' manuscript read simply "hosts". The error is regretted.

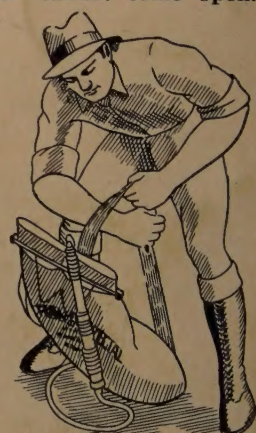
RANGER-SPECIAL

5-Gal. Water Bag & Spray Fire Pum

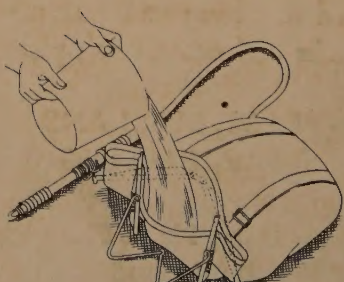
Extremely comfortable and easy to carry. Bag conforms to shape of your back without chafing or digging in.



Heavy rubber lined canvas prevents leakage, sweating—air tight closing vice locks automatically when sw closed—cannot come open.



Temperature resistivity of ca safeguards health of operator proofed against mildew, rot, rust — flexibility absorbs se shocks without damage.



Can be filled quickly by one man — large square opening makes interior of bag easily accessible for cleaning — can be rolled up and stored in limited space.

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Descriptive circulars with full particulars sent on request.